INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES
HRMARS MANAGEMENT ACADEMIC RESEARCH SOCIETY EXPLORING INTELLECTUAL CAPITAL
www.hrmars.com
ISSN: 2222-6990

Responses to Viewing an Indoor Vertical Greenery System: A Case Study

Aini Jasmin Ghazalli, Cris Brack

To Link this Article: http://dx.doi.org/10.6007/IJARBSS/v13-i7/17951 DOI:10.6007/IJARBSS/v13-i7/17951

Received: *11* May 2023, ***Revised:*** *12* June 2023, ***Accepted:*** *27* June 2023

Published Online: *18* July 2023

In-Text Citation: (Ghazalli & Brack, 2023)

To Cite this Article: Ghazalli, A. J., & Brack, C. (2023). Responses to Viewing an Indoor Vertical Greenery System: A Case Study. *International Journal of Academic Research in Business and Social Sciences*, *13*(7), 1794 – 1818.

Vol. 13, No. 7, 2023, Pg. 1794 – 1818

http://hrmars.com/index.php/pages/detail/IJARBSS | **JOURNAL HOMEPAGE**

Full Terms & Conditions of access and use can be found at
http://hrmars.com/index.php/pages/detail/publication-ethics

INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES
HRMARS MANAGEMENT ACADEMIC RESEARCH SOCIETY
EXPLORING INTELLECTUAL CAPITAL
www.hrmars.com
ISSN: 2222-6990

Responses to Viewing an Indoor Vertical Greenery System: A Case Study

Aini Jasmin Ghazalli
Fakulti Rekabentuk dan Senibina, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia.

Cris Brack
Australian National University
Corresponding Author's Email: jasmin.ghazalli@gmail.com

Abstract
Physical or virtual contact with greenery has positive impacts on human health. The presence of urban green spaces provides recreational opportunities, while for viewers the contact influences emotional states. For locations with limited floor space, green infrastructure such as a green roofs or vertical greenery can multiply exposure opportunities. In this case study, we sought to understand the responses of occupants to an indoor vertical greenery system (iVGS). This study explored the responses to the iVGS using a survey based on the Short-Version Revised Restoration Scale (SRRS), with responses collected onsite and online. The study examined the differences in responses between the respondents who were physically present at the iVGS (onsite) and those who viewed photographs of the iVGS online. The study also presents data on the number of passers-by before and after the iVGS was installed. Both online and onsite results revealed mostly positive responses towards the installation of the iVGS, with the onsite respondents giving higher scores than the online respondents. The restoration scores of iVGS demonstrates that it refreshes cognitive energy and brings positive impact and emotions. Responses to the SRSS provides tentative evidence that iVGS may have some restorative benefits, which is consistent with our understanding of the benefits of vertical greenery more generally. However, more research is required to confirm this.
Keywords: Human Response, Restorativeness, Vertical Greenery System, Indoor, Retrofitting

Introduction

Human responses to natural and built environments have been studied by various researchers. Responses to natural environments or scenes are generally recorded as positive, beneficial, and healthful (Kaplan & Kaplan, 1989; Parsons, 1991; Shibata & Suzuki, 2004; van den Berg et al., 2003). Responses to the built environment are either negative or mixed, depending on the experience provided by the scene (Ulrich, 1979). These experiences are influenced by the design, planning, and colour of the environment, and by the presence of greenery (Jackson, 2003; Kabisch et al., 2015; Radhi et al., 2014; Wolch et al., 2014). As a result of an increase in people moving into the built environment (WHO, 2021), there is a

need to increase total greenery exposure to benefit people, the environment, and the fauna living within it.

There are various types of urban green space. In urban areas, public parks are perhaps the most common green space. However, increases in urban population density often mean that hard surfaces, buildings, and other infrastructure increasingly occupy the horizontal space and reduce the available opportunities for adding traditional green spaces. Therefore, a number of urban planners recommend the use of urban green infrastructures (UGI) such as green roofs or vertical greenery.

Introducing greenery into the built environment provides space for people to enjoy the benefits of nature; in this way, the urban environment can promote positive emotions (Lohr & Pearson-Mims, 1996). Urban greenery offers not only beneficial environmental services such as air and water purification, noise filtering, and moderated urban temperatures (Bedimo-Rung et al., 2005; Chiesura, 2004; Weber et al., 2014), but also restorative opportunities (S. Kaplan, 1995; Matusiak & Klöckner, 2015; Rennit & Maikov, 2015). The very presence of green infrastructure creates aesthetic appeal and value (Abdul-Rahman et al., 2014; Montacchini et al., 2017; Weinmaster, 2009).

Previous studies have presented evidence of the positive effect of nature on humans including alleviating stress, increasing pain tolerance, and providing psychological benefits (Berto, 2014; Bratman et al., 2012; Bringslimark et al., 2009). Our ability to cope with stress is limited, and it has been found that spending time outdoors or otherwise viewing nature can assist in stress relief (Grahn & Stigsdotter, 2003; Parsons, 1991; Ulrich, 1979). Views of nature have been found to be preferred to views of urban scenes (de Groot & van den Born, 2003; Ulrich et al., 1991). However, many of these studies were limited, using only images portraying either forest-like views (with no human-made elements) or plain all-concrete urban areas. In practice, the urban environment exist along a continuum of no greenery present to large amounts of greenery. Studies have explored the effects of urban scenes with some amount of greenery, and these scenes were found to have restorative value (Fischl et al., 2007; Raanaas et al., 2011; Rennit & Maikov, 2015; van den Berg et al., 2014). For example, just viewing a simulated image of a rooftop covered with a flowering meadow was found to boost attention and be more restorative compared to a concrete roof scene (Lee et al., 2015). The presence of indoor greenery or indoor plants, as well as UGI such as an indoor vertical greenery system (iVGS), has also been shown to have positive effects on the indoor environment and users.

Wang et al (2016) concluded that an iVGS has various benefits, ranging from being aesthetically pleasurable to its ability to remove contaminants by filtering the air. Various studies have been conducted on the contributions made by indoor greenery, and have found it reduces classroom misbehavior (Han, 2008), increases work performance (Shibata & Suzuki, 2004), and improves indoor air quality (Fjeld et al., 1998). Findings on how indoor greenery and indoor UGI attenuates sound contrasts with that from outdoor greenery: VGS prevents 2 to 8% of sound from entering indoors (Fernández-Bregón et al., 2012); on the other hand iVGS has no effective sound mitigation (Wang et al., 2016). However, indoor plants may give the impression of creating a quieter environment as plants are perceived as lowering noise (Mediastika & Binarti, 2013).

Studies on the relationship of greenery views and psychological states (that is, of perception and emotion) have demonstrated that simple visual exposure to greenery has a positive impact. Allowing views or contact with greenery (indoor or outdoor) can thus help in recovering from daily stress (Grahn & Stigsdotter, 2003). Recovery, or restoration, occurs

when an individual experiences relief from elevated stress, anxiety, or any kind of negative mood or arousal. Restorative reactions manifest as psychological or physical improvements in the body. Restoration can occur through a reduction in stress from exposure to natural settings (Ulrich, 1983) or by replenishment of fatigue caused by prolonged directed attention (R. Kaplan & Kaplan, 1989). Studies of environmental aesthetics provide empirical findings that nature can reduce anxiety and provide restoration (Parsons, 1991). Views of green landscapes, plants, or UGI arouse increased attention (Fjeld et al., 1998; Li & Sullivan, 2016; Raanaas et al., 2011), improve work performance (Dravigne et al., 2008), reduces sick leave (Bringslimark et al., 2008), and tend to make a worker more consistent and make less mistakes (Lee et al., 2015). Views of greenery also make viewers less nervous or anxious (Chang & Chen, 2005). These positive outcomes show that views of greenery are restorative (Fischl et al., 2007; Li & Sullivan, 2016).

Viewing nature directly has been shown to have positive consequences to a person's psychological state, and even virtual greenery (images of plants) have been shown to have positive effects as well. A room with indoor plants enhances task performance (Evensen et al., 2015). Indoor UGI have high aesthetic value and lead to increased productivity and concentration (Montacchini et al., 2017). Virtually viewing indoor UGI has been found to help reduce stress (Yin et al., 2019, 2020) and the physiological response is immediate (Yin et al., 2020). Ulrich (1983) suggested that physically being in a certain setting allows restoration to occur, while Kaplan & Kaplan (1989) proposed that merely viewing nature—by being physically present or by observing photographs or videos—has restorative effects. The connection between these ideas is that nature is highly effective in ameliorating stress, regardless of whether nature is experienced through images or present in the actual environment. Given that the surrounding environment can prompt restoration (Han, 2003), greenery is essential for people residing in urban areas.

Most studies on the perceived restorative effects of greenery involve viewing visual aids, such as slides (Herzog et al., 2003), altered images (Lee et al., 2015), or audio-visual media (van den Berg et al., 2014). A study even constructed special rooms to investigate restorative effects (Fischl et al., 2007). Virtual reality (VR) experiments have also reported that greenery aids in reducing stress (Chan et al., 2021; Hedblom et al., 2019). A study comparing outdoor and virtual nature using 360-degree VR was found to have similar restorative effects (Browning et al., 2020). Images, videos, or posters may provide immediate restorative effects, although the use of living plants may provide longer-lasting outcomes (Chen et al., 2016).

There are various methods and tools developed by researchers to record restorative effects. These self-reporting questionnaires have been developed mostly based on Stress Reduction Theory (SRT) (Ulrich, 1981) and Attention Restorative Theory (ART) (R. Kaplan & Kaplan, 1989). According to SRT, the calming effect of nature helps reduce stress, while ART proposes that environmental elements (including nature) provide effortless attention that directs our attention and restores our mental capacity. Examples of tools to measure restoration include the Perceived Restorativeness Scale (PRS), Revised Perceived Restorativeness scale (RPRS), Perceived Restorative Potential (PRP), Restorative State Scale (RSS), Restoration Scale (RS), and Short-Version Revised Restoration scale (SRRS). All these methods have been shown to be reliable to quantify the restorativeness of views, settings, or environmental conditions (e.g., Herzog et al., 2003; Paddle & Gilliland, 2016; Van den Berg et al., 2014).

Evans (2003, p.536) stated that 'the built environment can indirectly impact mental health by altering psychosocial processes with known mental health consequences', and the installation of a VGS or iVGS may be highly beneficial because of the flexibility of its planting or growing

system. VGS in the urban environment has been determined to not only have economic benefits, but also environmental, ecosystem, and aesthetic benefits. Even indoor vertical spaces offer the potential for greenery retrofitting. Where natural light is available, or with the use of the correct artificial lighting (Egea et al., 2014), iVGS can thrive. Compared with green roofs, vertical spaces on buildings offer more opportunities for greenery retrofitting, greater coverage, and a pleasant visual appearance; however, they may compete with the need for windows and enough corridor width.

This study tests the hypothesis that an iVGS will evoke positive responses in emotional, physiological, and psychological aspects, and, further, will have restoration benefits. Additionally, this study examined the differences in responses between respondents who were actually next to the iVGS (onsite) and respondents who viewed photographs of it online.

Method

Site study

The iVGS used in this study was installed inside Building 48, one of the buildings at the Fenner School of Environment and Society (Fenner School), Australian National University (ANU). The Fenner School offers a range of programs at undergraduate and postgraduate levels, including ecology, forestry, geography, and climatology; therefore, many students were presumed to have an interest in the natural environment. Lectures for other disciplines are also scheduled in this building, so a number of other students had the opportunity of walking through the case study corridors.

The ground floor of Building 48 is typically busy as the hallways and corridors are passageways for students and staff to reach their offices, lecture halls, or laboratories (Figure 1). Before the iVGS was installed, a counter was installed in both parallel corridors to record the number of users. Figure 2 shows images of north corridor (without iVGS) and south corridor (with iVGS). The images were taken from the building lobby. Data were recorded using an N287 Commercial Grade Doorway Beam unit (Figure 3).

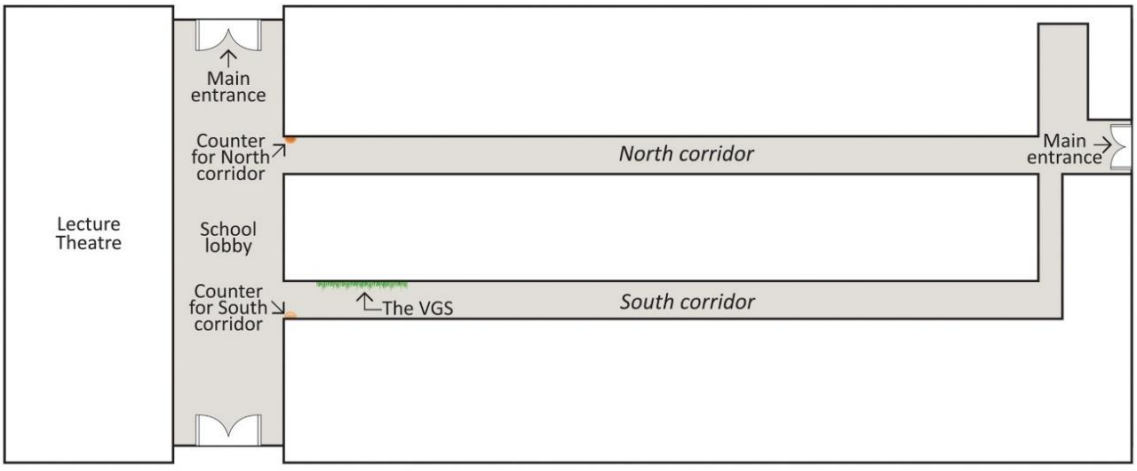

Figure 1: Floor plan of the site study, showing the location of the Lecture Theatre, the two main entrances, location of the indoor vertical greenery system, and the parallel corridors.

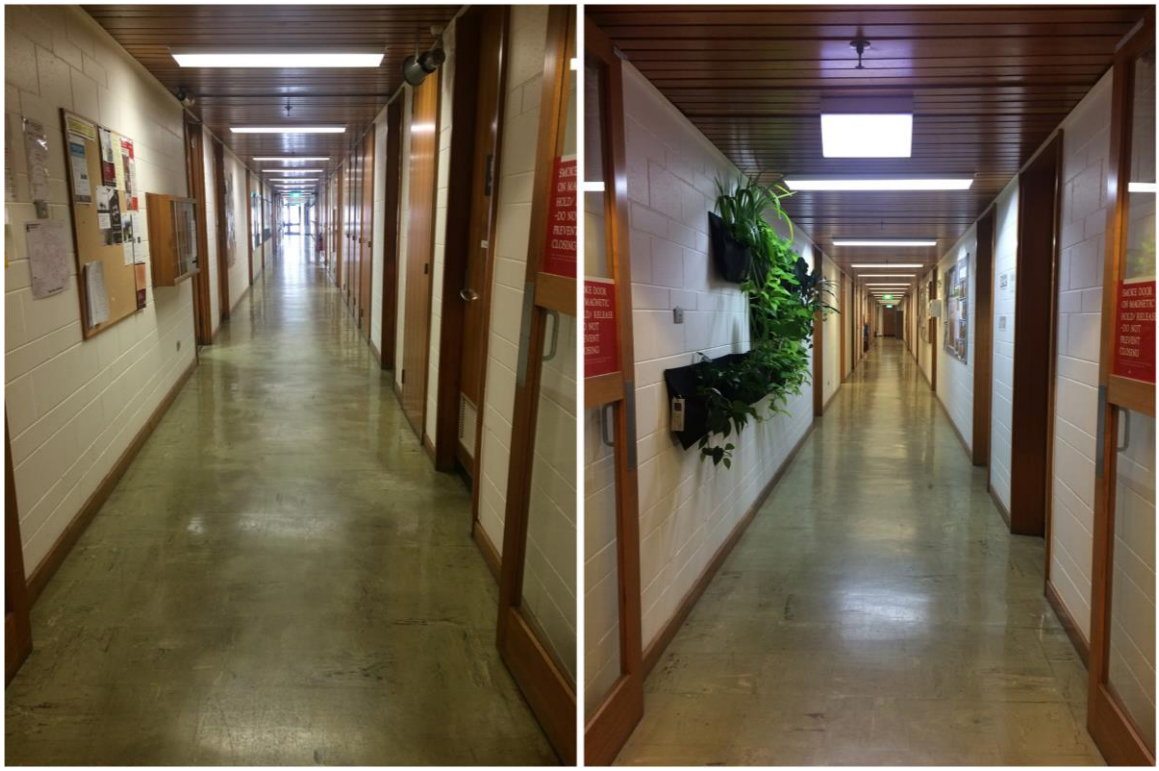

Figure 2: Images of north corridor (without iVGS) and south corridor (with iVGS). Picture taken from the building lobby.

Figure 3: N287 Commercial Grade Doorway Beam unit installed in the north corridor.

The iVGS used a pocket system in which there was a soil mixture and plants selected to survive under artificial light. Nine plant species were used in this study: *Dracaena deremensis* ('Warneckii'); *Neomarica gracilis*; *Philodendron cordatum*; *Schlumbergera truncata* hybrids; *Monstera deliciosa*; *Nephrolepis biserrata* ('Macho'); *Hoya pubicalyx* ('Royal Hawaiian'); *Philodendron cordatum* ('Goldilocks'); and *Cissus rhombifolia*. These plants are tolerant of low light, and some are commonly used for indoor landscaping. Commercial potting mix was used, and the plants were watered and fertilised as needed.

Measuring the Perceived Restorative Effect

Restoration is the process of returning something to its former or original condition. To solicit responses by building users to iVGS, a survey based on the Short-Version Revised Restoration scale (or SRRS) was adopted. The SRRS is a simplified and more practical version of the Restoration Scale, which has 17 variables (Han, 2003). SRRS has been found to be reliable, with a 9-point scale to measure responses, and has been used by other studies (Gatersleben & Andrews, 2013; Han, 2007; Paddle & Gilliland, 2016). SRSS asked respondents about their emotions, physiological responses, cognitive (mental process) response, and behaviour upon viewing the iVGS. SRSS had high internal consistency (Gatersleben & Andrews, 2013) and reliability analysis demonstrated SRSS to be very reliable (Han, 2003) and such a high score shows that a self-reporting questionnaire like SRSS is capable of assessing the restorative value of iVGS through a combination of behavioural and physiological measurements (Berto, 2014).

The self-rating survey asked respondents to say how much they agreed with the questions, and a restoration score was obtained by calculating the overall mean across the items. However, the physiological dimension scores were reversed, as here the opposite of restorativeness was measured (Han, 2003). The items making up the restoration scales used here are set out in Table 1. The only difference between the questions in Table 1 with the original questions in SRRS developed by Han (2003) is the emotion dimension, where instead of 'grouchy', this study asked if the respondents felt 'irritated'.

Table 1
Items making up the restorative scale.

How would you describe your emotional response?										
Very much irritated	1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □	Very good natured
Very anxious	1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □	Very relaxed
How would you describe your psychological response?										
Breathing faster (not at all)	1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □	Breathing faster (very much so)
Hands are sweating (not at all)	1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □	Hands are sweating (very much so)
How would you describe your cognitive response?										
Not interested in the scene at all	1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □	Very much interested in the scene
Not at all attentive to the scene	1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □	Very much attentive to the scene
How would you describe your behavioural response?										
Not at all want to visit more often	1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □	Very much want to visit more often
Not at all want to stay here longer	1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □	Very much want to stay here longer

In the study where the SRSS was developed, the author provided detailed explanation regarding the selection of questions based on the four dimensions measured (emotions,

physiological response, cognitive, and behaviour) (Han, 2003). The emotional dimension of the scale measures mood, which covers negative as well as positive feelings. Measuring physiological responses is complex. However, based on previous studies, there is enough evidence that supports self-reporting of these measures (Berto, 2014; Qin et al., 2013). The cognitive dimension of SRRS provides insights on the relationship between respondents and the environment. Finally, the behaviour dimensions are evaluated by a tendency to approach or avoid a scene/environment. Due to the broader perspective of SRRS, this self-rating questionnaire is the one most suitable to gauge the restorativeness of iVGS, since iVGS is neither an urban nor natural setting.

Data Collection and Analysis

I surveyed both onsite and online respondents. The survey began in November 2015, 5 months after the iVGS was installed in the south corridor (Figure 2). Data were collected until September 2016 for both onsite and online surveys. For the onsite respondents, a poster was placed on the wall opposite the iVGS describing the plants used with some information about what vertical greenery is, and at the bottom of the poster was an invitation to participate in a survey (Figure 4). A participant information sheet and hard copies of the survey were provided alongside a locked box for return of the completed survey. The onsite respondents also had the freedom to physically touch the installation and engage their senses beyond just sight. The location of the poster, iVGS, and the ballot box are as shown in Figure 5.

Because some students may have been too busy to stop and experience the installation for enough time, an identical survey was provided online. A quick response (QR) code was printed on the poster and it linked to an online survey. A link to the survey was also placed on the student intranet information system, which could be viewed by all students enrolled at the Fenner School. An invitation to participate was sent out using the school's email system to all non-students and postgraduate students at the Fenner School. Ethics approval was obtained through the ANU Ethics Committee before the survey commenced.

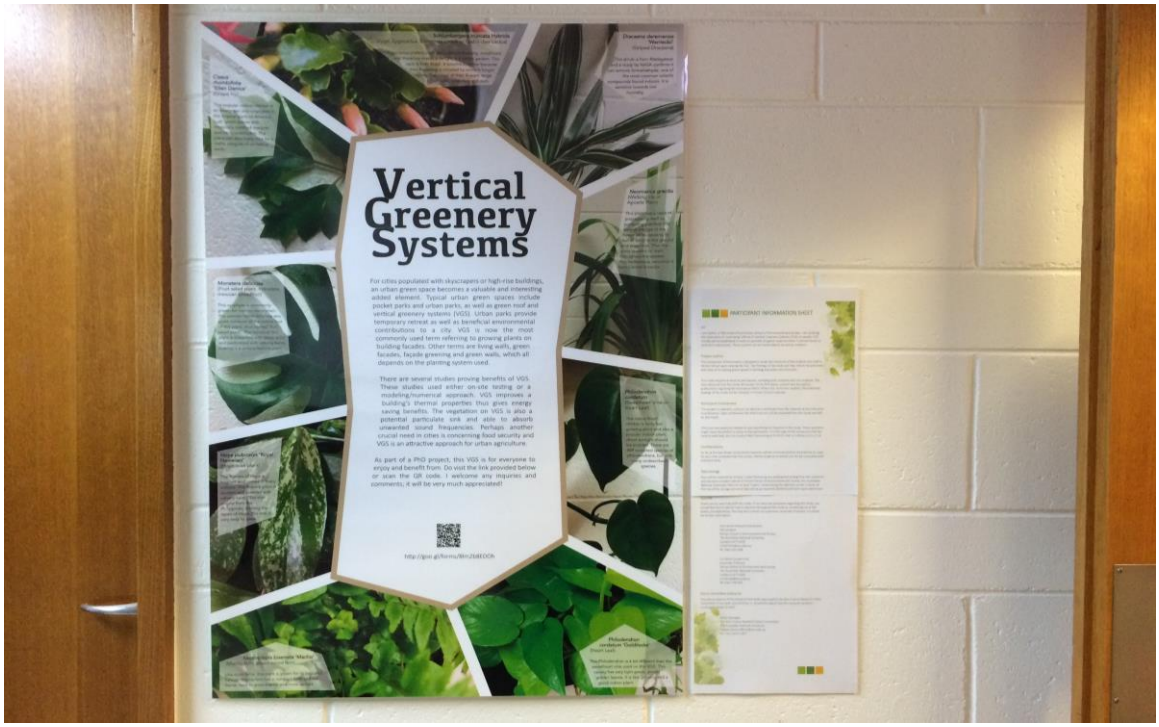

Figure 4: Poster on the wall opposite the iVGS displaying brief information on what is vertical greenery and the plants used, invitation to answer the survey, as well as participant information sheet.

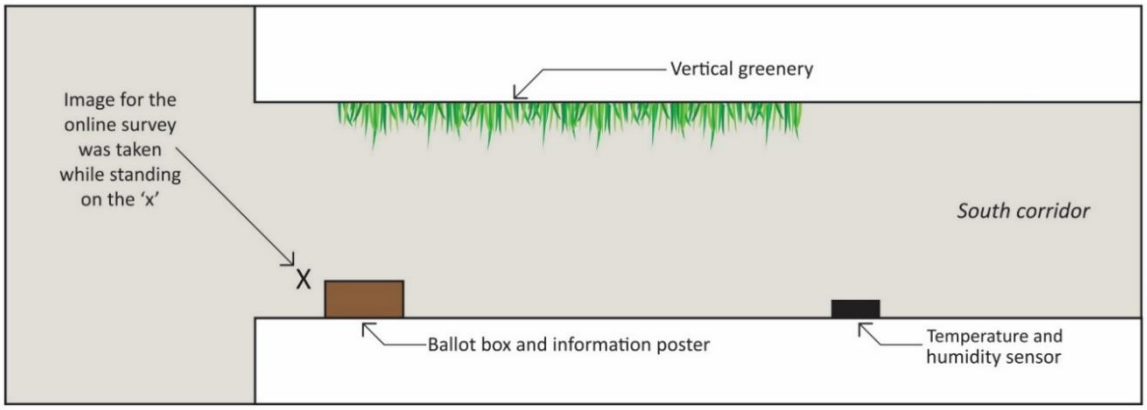

Figure 5: Location of the iVGS, poster with participant information sheet and the ballot box for onsite respondents to return the survey sheet, located in the south corridor of Building 48, Fenner School of Environment and Society (Fenner School).

For the online survey, the online questionnaires collected the same information as the onsite study. The online questionnaire was accompanied with an image of the iVGS taken from the same location as the poster to provide a similar view of the vertical greenery to that of the onsite respondents. Figure 6 shows a screenshot of the online survey, distributed using Google Docs. The SRRS was used to capture the respondents' responses to the iVGS, and an open-ended question was also provided for the respondents to add opinions, thoughts, and other comments regarding the study.

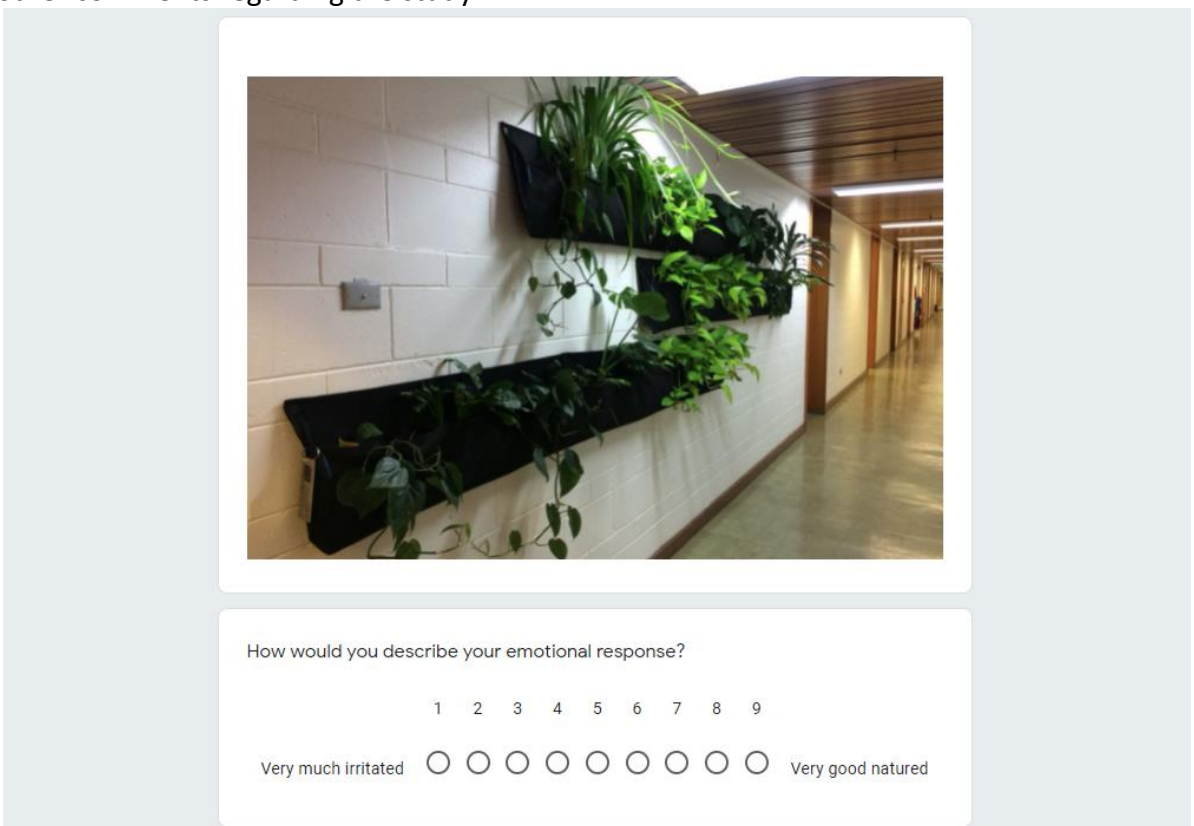

Figure 6: Screen shot of the online survey distributed to respondents using Google Docs showing view of the iVGS if participants stand next to the information poster onsite.

To calculate the SRSS index scores, the scores of the two variables of the four dimensions were first averaged among the scores provided by the respondents. After then, the physiological dimension's aggregate score was reversed. This is because physiological arousal, which is the opposite of restorativeness, is measured by this dimension. The final index score was then calculated by averaging all of the composite values and preparing the data for analysis (Han, 2003). To further support SRSS findings, reliability test (Cronbach's α) for each dimension was also calculated. Reliability coefficient of 0.70 and above is better, 0.80 and above is considered robust and reliable, and 0.90 and above is considered strong/excellent (Taber, 2018). To further see if there was any difference in responses between online and onsite respondents, a t-test was conducted. A t-test is an inferential statistic that is used to see if there is a significant difference between two groups' means. Both t-test and Cronbach's α for each dimension was calculated in Microsoft Excel (Microsoft Corp., USA).

Analysis of the open-ended question was done by pooling the terms or words into similar categories. Categorising written expressions can sometimes be misleading, so classifications of the recognisable keywords were guided by definitions derived from websites such as *dictionary.com* (Dictionary.com, n.d.) and *thesaurus.com* (Thesaurus.com, n.d.). Definitions from previous studies related to each response category were also adapted in this study. All comments were grouped based on recognisable keywords, such as 'like', 'pleasant', 'enjoy', and 'fascinating'.

Results

General information

In 2015, the Fenner School was the place of learning for 1058 students, with 704 undergraduates and 354 postgraduates. However, because the Fenner School offers a range of classes, there were also students from other schools as well. Out of the total 1058 students, 662 were from other schools with 113 postgraduate students. Only 396 were Fenner School students, with 155 undergraduates, 100 postgraduate (higher degree coursework students), and 141 higher degree research (HDR) students. The Fenner School is also a place of work for a total of 588 staff. The 588 staff are transient and consist of recurrent staff, casual staff (non-teaching), casual staff (teaching), as well as all visitors (affiliates, campus visitors). In total, there are 1646 individuals working and learning in the Fenner School in 2015.

Overall, this case study received 73 online and 31 onsite responses, meaning that 6.3% of the total Fenner School population responded to this study. For the online respondents, 53% were Fenner School (undergraduate, postgraduate, and HDR) students, 21% were students from other schools (undergraduate, postgraduate, and HDR), and 26% were not students. For onsite respondents, 45% of respondents were Fenner School students (undergraduate, postgraduate, and HDR), 13% were students from other schools (undergraduate, postgraduate, and HDR), 32% were not students, and 10% did not leave any answer. Breakdown of the numbers into Fenner School students, students from other schools, not students, and unknown is shown in Figure 7. For 'not a student', the respondents were Fenner School staff, with just one respondent who was a Fenner School alumnus.

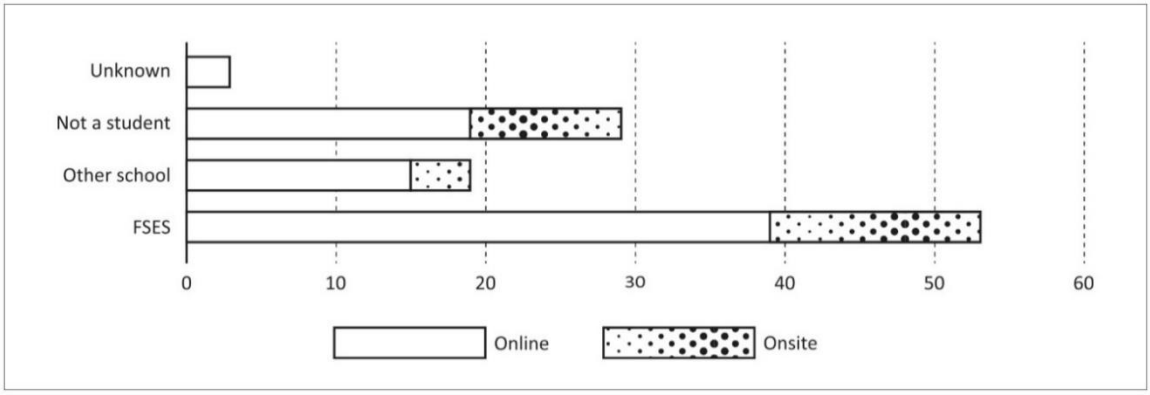

Figure 7: Numbers of Fenner students, non-students and students from other schools responding to the survey.

Short-Version Revised Restoration Scale (SRRS) findings

The score for each SRSS item ranged from 1 to 9, and there were two questions for each response category: emotional, cognitive, behavioural, and physiological (Table 1). Table 2 gives an overview of the respondents' mean ratings of perceived restoration (and standard deviations). A mean value above the midpoint of the 9-point rating indicates that the iVGS is generally perceived as restorative. The high mean ratings shown in Table 2 demonstrate the iVGS is perceived as restorative, with onsite respondents scoring slightly higher than the online respondents. For the overall scores, iVGS had a greater impact on the respondents' physiological dimension, followed by the cognitive and emotional, and finally the behavioural dimension. For the online respondents, again iVGS had a greater impact on the respondents' physiological dimension, followed by emotional and cognitive, and finally the behavioural dimension. The onsite respondents' response was different, as the cognitive dimension was rated the highest, then the physiological and behavioural, and finally the emotional dimension. The four dimensions (each consisting of two items) showed sufficient reliability. The Cronbach's α for the scores was 0.91 for the emotional dimension, 0.77 for the physiological dimension, 0.94 for the cognitive dimension and 0.96 for the behavioural dimension.

Table 2
Means and (standard deviations) for subscale scores and the overall SRSS score

Respondents	*Emotional*	*Physiological*	*Cognitive*	*Behavioural*	*Overall*
All	7.32 (1.61)	7.64 (1.91)	7.44 (1.53)	6.68 (1.74)	**7.27 (1.70)**
Online	7.29 (1.47)	7.53 (1.94)	7.23 (1.60)	6.35 (1.74)	**7.10 (1.69)**
Onsite	7.38 (1.94)	7.88 (1.85)	7.93 (1.22)	7.50 (1.43)	**7.68 (1.61)**

Table 3: T-tests comparing online and onsite scores, as rated by respondents of this study. The response in Q1 and Q2 questions asked in each dimension were compared between online and onsite respondents. Further the responses were grouped in overall comparing the online and onsite respondents. Significant differences are indicated with asterisk (*).

Emotional, physiological, cognitive, and behavioural dimensions inquiries in SRSS	*Difference between online and onsite*	
	Q1 and Q2	Overall
Emotional dimension		

Q1: When respondents are `asked if they felt irritated or good-natured	$p = 0.03$*	$p = 0.700$
Q2: When respondents are asked if they feel anxious or relaxed	$p = 0.29$	
Physiological dimension		
Q1: When respondents are asked if they were breathing more rapidly	$p = 0.36$	$p = 0.23$
Q2: When respondents are asked if their hands were sweating	$p = 0.44$	
Cognitive dimension		
Q1: When respondents are asked if they felt attentive towards the iVGS	$p = 0.17$	$p = 0.003$*
Q2: When respondents are asked if they are more interested in the scene	$p = 0.01$*	
Behavioural dimension		
Q1: When respondents are asked if they want to stay longer	$p = 0.01$*	$p = 0.00001$*
Q2: When respondents are asked if they want to visit more frequently	$p = 0.0003$*	

Data from the SRSS was used to test if there was a significant difference between online and onsite respondents' responses (Table 3). For the emotional dimension, statistical analysis showed significant differences between the online and onsite respondents when asked if they felt irritated or good-natured ($p = 0.03$) and no significant difference between the online and onsite respondents when asked if they felt anxious or relaxed ($p = 0.29$). For the physiological dimension, there were no significant differences between the online and onsite respondents when asked if they were breathing more rapidly ($p = 0.36$) or if their hands were sweating ($p = 0.44$). For the cognitive dimension, no significant difference was found between the online and onsite respondents when asked if they felt attentive towards the iVGS ($p = 0.17$); however, a significant difference was found with onsite respondents being more interested in the scene ($p = 0.01$). Finally, there were significant and substantial differences in the behavioural dimension, with respondents wanting to stay longer ($p = 0.01$) and visit more frequently ($p = 0.0003$) when they were at the actual iVGS than when responding online. The findings showed that respondents generally provided positive ratings for emotional response, cognitive response, and behavioural response. The respondents reported feeling generally more relaxed, good-natured, interested, and attentive, as opposed to irritated, anxious, not interested, and not attentive. Behaviourally, the findings showed that respondents wanted to stay longer at the iVGS installation.

Written feedback (open-ended question)

Some of the respondents provided feedback in the open-ended question. Some 45% percent of the respondents gave written feedback (47 out of 104), being 66% from online respondents and 34% from the onsite respondents. The written comments were mostly positive. Emotional response may be a bit complex to identify because emotional response can be measured through affective reactions, physiological response, or behavioural acts (Bradley & Lang, 1994). Based on the fact that some statements may not fit exclusively into specific responses, classification was based on the context of the respondents' written

feedback and the definitions derived from sources such as dictionaries and previous research. This study also received some suggestions and opinions that had no relation to their emotional, cognitive, physiology, or behavioural responses. One comment stated that "Reactions to an image is different to the real thing". However, recent studies employing a 360-degree VR study complete with audio stimuli have proven that an image can be an emotionally beneficial alternative for people that cannot immerse themselves in natural surroundings (Hedblom et al., 2019). The relationship between restorative scores and written findings are further discussed in the next section. Categorisation of the written responses of this study are shown in Table 4.

Table 4.4

Categorisation of statements/feedback provided by respondents in the open-ended questions. Categories with asterisk (*) are considered negative feedback. 'e' category represents emotional response, 'c' represents cognitive response, and 'b' represents behavioural response. Statement with superscript 1 ([1]) are statements from online respondents while superscript 2 ([2]) are statements from onsite respondents.

Category	Statements
e*	I don't have any strong feelings or thoughts about VG[1]
e, c	I like the vertical greenery hanging in forestry, it brightens up a dark, somewhat depressing hallway[1]
e, c	I love the idea of incorporating greenery within indoor spaces - I am especially interested in some of the plants that have been identified (by NASA) as able to process impurities in the air[1]
e, b	I like the plants and would like to see more around the school. It would be interesting to have them in places like waiting rooms, where people have to hang around and get impatient[1]
e, c	Lovely experiment - we are all enjoying it[1]
e	I love the greenery[1]
c	One thought: difficult to decide whether my (positive) response is because it is greenery/plants, or whether partly simply because it is a pleasant visual interruption in an otherwise normal corridor[1]
e	I love green walls[1]
e, c, b	My immediate response when I first saw the plants up on the wall brought a smile to my face; and second, whenever I walk down the stairs or walk past I mostly always feel compelled to look at the plants on the wall. How pleasant and what a great idea it is[1]
e, c, b	Including indoor greenery in work environments is an excellent idea with known beneficial effects for those working in these environments. I am interested in this particular approach to that inclusion, in terms of visual amenity, space requirements, maintenance needs and installation and maintenance costs. It seems to me to be very positive in all these respects[1]
e, b	I love walking past the wall, looking at it and enjoying its presence. I would like one in my room[1]
c	Really support what you are doing Jasmin; I really believe in Urban Forestry and the correct management of soils used in an urban environment[1]
e, c	I believe there should be more VGS. They really give the workplace a different feel and vibe[1]

e, c	Indoor plants are terrific. I find buildings with indoor plants significantly more pleasant to work in. I want to learn more about how to care for them so I can do the same in my house[1]
e, c	Thank you for adding such a delightful feature to such a dull corridor. It is beautiful[1]
e, c, b	When I walk down that corridor I always find my eyes drawn to the wall with the greenery. I don't linger (though I did the first time when I think there were some *zygocactus* in flower) but I get a pleasant feeling. My mood lightens and I smile[1]
e, c	In general, I really like vertical greenery, and think it makes a room more attractive and relaxing[1]
e, c	When the plants are flowering I find the green wall particularly interesting. Also seeing new growth is exciting. I think it is the changes in the overall scene that attract most of my attention[1]
e	Saw the vertical greenery building near Eiffel Tower in Paris it was an eye catcher and I'd be happy to see more around even though I'm ambivalent to them overall[1]
e, c	I find vertical greenery very fascinating. As I understand that our dependence on plants is crucial for survival in many ways, to the least it beautifies any place[1]
b, c	VG area is a good thing to relax myself from a routine. However, with only one spot in the building and there are many other options to enjoy directly the nature outside my building, I prefer to enjoy the nature actually. This adds the fact that the natural view is displayed quickly and I need effort to travel to see the VG[1]
c	Hello, your project is very interesting. I identify myself characterized with this because we were thinking of having plants or something similar but we live in a building which represents a barrier for us to do so. I'd like to know more about what kind of indoor plants can be used, . I think is a very good system[1]
c	I think some PhD students in Fenner are too stressed out to stop and look at the lovely greenery wall[1]
e, c	This project sounds super interesting and I'd love to hear more about it[1]
P*	I don't believe that anyone gets sweaty hands as a psychological reaction to a green wall[1]
e	Other plant types? Very nice VGS! Thoughts of running water feature?[2]
e, c	I wonder about how plants are tended to-- how do they get water, how often etc? They seem to be doing well, so someone must be watching out for them (perhaps a small sign on the side could give this info + educate folks-- so someone like doesn't worry). Great to have, to enjoy. I like the diversity of plants[2]
e, c	Looks great! I wish there was more around[2]
e, c	Beautiful! I want to see more of this[2]
c	Need more VGS's particularly indoors[2]
c, b	The greenery really improves the space and makes it more inviting and a unique feature of the building[2]
c	I think it makes the corridor seem happier[2]
e, c, b, p	This greenery in the corridor is beautiful and I look for it every time I am in the building. I feel it almost balances out the artificial lighting and infrastructure.

	The organic shapes make me feel relaxed and grounds me, makes me feel more whole. It helps to remind me that life goes on regardless of the day-to-day stress[2]
e, c	I think vertical greenery is a fantastic idea. The air seems fresher and it is pleasant to be around[2]
e, c	I really love the green space - it makes a bland hallway so much more beautiful and happier to walk past. I'd love to see more around. Also, this one is really well maintained[2]
c	Can I have some in my office? I think they are fantastic and want more of them around the building at FSES[2]
e	The fluorescent lights make it seem a bit laboratory-like but overall I like it[2]
e, c	Very nice project! I was feeling I would like the garden was bigger[2]
e	Amazing idea! I'm from the city (Toronto and Montreal, Canada) and hate the buildings. This would be a fantastic way to naturally renovate cities back into a more tolerable and delightful living space/condition[2]
c	More green walls in Canberra[2]

Discussion

This case study tested the hypothesis that an iVGS evokes positive responses in emotional, physiological, and psychological aspects, and, further, will have restoration benefits. Including online respondents in the survey enabled me to sample a greater number of people and evaluate whether perceptions of iVGS vary if it is experienced in person or virtually. Results showed the iVGS was perceived as restorative by refreshing cognitive energy and brings positive emotions. The results of the SRSS suggest that iVGS may have some restorative properties, which is consistent with our understanding of the benefits of vertical greenery in general. Findings showed the onsite findings gave stronger and more positive responses. Although some dimensions indicated no significant differences between online and onsite respondents, the behavioural dimension showed very significant differences (Table 3). Onsite ratings tended towards the maximum scores possible in the survey, showing that the respondents were very interested and attentive towards the iVGS, felt relaxed and good natured, very keen to remain longer near the iVGS, and to visit the iVGS more frequently.

Generally, the respondents liked the iVGS and the idea of having plants in the corridor. Some respondents were very satisfied with the variety of plants, although they would have liked the iVGS to be larger. The greenery beautified the hallway, and one respondent wrote that the 'air seems fresher', making them 'happy' to walk past it. The particulate matter levels were also shown to reduce after installation of the iVGS, as confirmed by earlier studies (Ghazalli et al., 2018).

One respondent provided a negative response, with the iVGS not evoking any feelings or thoughts (Table 4). As identified by previous studies, greenery can generate negative effects (Grinde & Patil, 2009; Larsen et al., 1998; Shibata & Suzuki, 2004) and the possible explanation for this contrary response is that people prefer scenes with an abundance of nature (Han, 2007). The iVGS installation is clearly just a small extension of nature. However, most respondents indicated they were highly interested in and attentive towards the iVGS. This can be related to a sense of attachment that humans have with nature (Berto, 2014; Chang & Chen, 2005).

Emotional Dimension

For the emotional dimension, the overall SRSS score was the third highest recorded in this study (*M* = 7.32, *SD* = 1.61), with onsite respondent having a slightly greater score (Table 2). It was presumed that physical contact would generate stronger emotions; however, it is also possible that the online respondents had prior physical contact with the iVGS, as suggested by the non-significant difference (p = 0.7) between the onsite and online respondents for the emotional response category (Table 3). Some of the comments were that the iVGS was 'attractive', 'relaxing', and 'interesting'. One respondent claimed that the building was 'significantly more pleasant to work in'. The presence of plants in the corridor provided a pleasant visual distraction and 'brightens up somewhat depressing hallway'. Even though there was not any significant difference in general between the online and onsite respondents, one of the emotional response item ratings was significantly different: when the respondents were asked if they felt irritated or good-natured (p = 0.03). On the other hand, there was no significant difference when the respondents were asked if they feel anxious or relaxed (p = 0.29). These two items have an internal consistency of Cronbach's $\alpha = 0.84$.

The numerical findings of the SRSS on emotional dimension are further supported by the responses provided in the open-ended questions. Words related to emotion can be divided into positive feeling words and negative feeling words. Examples of positive feeling words include excited and comfortable, while examples of negative feeling words include ugly and dirty. Emotion is defined as 'an affective state of consciousness in which joy, sorrow, fear, hate, or the like, is experienced, as distinguished from cognitive and volitional states of consciousness' (Dictionary.com, n.d.). Love, shame, anger, sympathy, and happiness are other words related to emotion. Bradley & Lang (1994, p.53) measured emotions identifiable as 'happy, pleased, satisfied, contented, hopeful, relaxed', as well as 'unhappy, annoyed, unsatisfied, melancholic, despairing, or bored'. Therefore, for this study, keywords such as 'smile', 'love', 'happy', and 'beautiful' best represent the emotional response category. Overall, there were 29 written responses related to emotion, with 10 onsite and 19 online. One negative emotional response (e*) was recorded, as shown in Table 4.

Physiological Dimension

Previous studies derived their physiological data from electrocardiograms or electroencephalograms (e.g., Qin et al., 2013; Tyrväinen et al., 2014). Even though this study was based on self-reporting using SRRS, this tool has been shown to be reliable in assessing restorative value (Berto, 2014; Han, 2003). According to Qin et al. (2013), data collection via a perception-based approach is reliable if it achieves high levels of internal reliability, and measuring tools such as SRRS fit this category (Han, 2003). In this study data collected using SRRS was based on visual exposure, either online or onsite. Kaplan (1995) proposed that improvement in cognitive functioning is affected by visual contact with nature, while Ulrich (1993) maintained that mood affected cognitive functioning. Both theories suppose that positive or negative responses to the environment can be prompted via various approaches.

The overall SRRS score for the physiological dimension of this study was, surprisingly, the second highest (*M* = 7.64, *SD* = 1.91), with higher onsite ratings (Table 2). When comparing online and onsite responses, there was no significant difference (p = 0.23), even when both questions in the physiological dimension were considered (Table 3). Both items in the physiological dimension have an internal consistency of Cronbach's $\alpha = 0.75$, which is acceptable. Manifestation of physiological responses, as gauged by written responses in this study, received the lowest response. Physiology is defined as 'the branch of biology dealing

with the functions and activities of living organisms and their parts, including all physical and chemical processes' (Dictionary.com, n.d.), and so to provide written feedback might have been a challenge. In total, there were two comments fitting the physiological response category. One negative physiological reaction was recorded in the online response, stating 'I don't believe that anyone gets sweaty hands as a psychological reaction to a green wall', and one onsite positive response, stating 'The organic shapes make me feel relaxed and grounds me, makes me feel more whole'.

Cognitive Dimension

The questions for the cognitive response category asked whether the respondents were interested in or felt attentive towards the scene. The cognitive dimension of this study received the highest score (M = 7.44, SD = 1.53), with the onsite respondents providing higher ratings than the online respondents (Table 2); this is also reflected in the significant difference found between the overall online and onsite findings (p = 0.003). Cognition is defined as 'of or relating to the mental processes of perception, memory, judgment, and reasoning, as contrasted with emotional and volitional processes' (Dictionary.com, n.d.). Due to the introduction of new element in the corridor, this may have intrigued the respondents' curiosity and interest, and this is reflected in the written responses. The written cognitive response in this study also recorded the highest rating compared to other categories. Overall, there were 30 written responses related to cognition, with 12 onsite and 18 online. As shown in Table 3, no significant difference was found between the online and onsite respondents when asked if they felt attentive towards the iVGS (p = 0.17), but a significant difference was found with onsite respondents being more interested in the scene (p = 0.01). Both items in the cognitive dimension have good internal consistency with a Cronbach's α = 0.86.

Identifying written cognitive responses however can be misleading in terms of emotional responses because cognition involves mental process such as memory. As a result, emotional responses may be affected by unconscious cognitive responses. To ensure clarity, this study defined cognitive capacities as those involving attention, memory, emotional state, or stress (Bratman et al., 2012). Thus, the keywords under cognitive response in this study were associated with thinking as well as understanding, such as 'interest' and 'different'. One respondent commented about the condition of the plants by saying that the system 'looks a bit unhealthy, and just "hanging there" even though it isn't unhealthy'. Other feedback related to cognitive responses included questions such as 'I think more opportunities at/around ANU to display vertical greenery the better' and 'Other plant types? Thoughts of running water feature?'. Perhaps the most interesting written feedback was how a non-student respondent wrote 'Can I have some in my office?' without rating the SRRS questionnaire. There was also another respondent who would like an iVGS in his/her room (Table 4). Some non-students showed high appreciation in their written feedback, stating that the iVGS was a 'delightful feature', was 'fascinating', and gave the building a 'different feel and vibe'.

Behavioural Dimension

The final dimension is the behavioural, which asked if the respondents wanted to visit more or stay longer at the scene. The overall SRRS scores were M = 6.68, SD =1.74, with higher onsite ratings (Table 2). The higher onsite SRRS scores were also reflected in a significant difference, with respondents wanting to stay longer (p = 0.01) and visit more frequently (p = 0.0003) when they were at the actual iVGS than when they were responding online (Table

4.3). Both items in the behavioural dimension have good internal consistency of Cronbach's α = 0.89. There were more written responses relating to emotion compared to behaviour, but ratings for the onsite behavioural response were higher than the onsite emotional scores (Table 2), showing that the iVGS elicited stronger behavioural than emotional effects, with a significant difference between the online and onsite responses. The respondents also reflected this behavioural finding in their written feedback.

Behaviour is the 'manner of behaving or acting' and is defined as a pattern (Dictionary.com, n.d.). Words related to behaviour presented on the *dictionory.com* website include attitude, role, action, and demeanour. The behavioural response category in this study was identifiable using keywords such as 'pleasant', 'mood', 'enjoy', and 'exciting'. Overall, there were 8 written responses related to emotion, with 2 onsite and 6 online. Ulrich (1979) says that the preference towards greenery is multi-sensory, meaning that physically being present in the scene allowed respondents to be immersed in it and might be the reason for the higher scores among the onsite respondents (Table 2). Other than written responses on behaviour, this study also recorded data on the number of users in the corridor before and after the iVGS installation. Changes in walking behaviour demonstrated in this study were published in a previous study and the data showed that more people chose to use the corridor with iVGS (Ghazalli et al., 2018).

Mood, stress, and physical environment are some of the factors that affect behaviour. The positive responses that the respondents displayed towards the iVGS may explain why they commented that they would like to have 'more' VGSs, as they provide a place to 'relax from routine'. The addition of the iVGS 'compelled [the respondents] to look at the plants' every time they entered the building, and the respondents claimed that the iVGS improved their mood and caused them to smile. An online respondent expressed the opinion that the iVGS provided 'the same positive feeling when seeing colourful pot plants', while an onsite respondent stated that it 'improves the space', making it more 'inviting' and 'a unique feature'. The organic shape provided by the plants was appreciated and a respondent described the iVGS as 'a fantastic way to renovate cities back into a more tolerable and delightful living space'. Generally, Canberra is a place with plenty of green spaces, with avenue plantings, green belts, as well as pocket parks, yet the respondents still rated the iVGS as restorative. A previous study found that people with access to green spaces at home are likely to enjoy other green spaces as well (Grahn & Stigsdotter, 2003).

Other Findings

SRSS collects perceived restorative outcomes by inquiring on the emotional, physiological, cognitive, and behavioural responses. This study also collected additional information in the open-ended question. Although there were concerns about the plants looking 'unhealthy', the respondents commented that the iVGS 'balances out the artificial lighting and infrastructure' and 'changes the overall scene'. The iVGS was also considered a 'pleasant visual interruption in an otherwise normal corridor'. Some respondents suggested that there should be more iVGS installations in the school building and that they should be included in waiting rooms. Conclusions of this finding were shared with the Director of Fenner School, who subsequently arranged installations of several more iVGSs in the school building.

As a tertiary institution and a public research university, life as a student or staff member is generally overwhelmed with exams, deadlines, life problems, financial worries, and relationship issues. This study did not ask the current state of the respondents (whether they felt stressed or overwhelmed) but it did assume that the respondents experienced some level

of stress in their daily activities. According to an observation in a previous study, a high preference for greenery is linked with a high level of stress (van den Berg et al., 2003). High preference for greenery is also associated with greater affective restoration and therefore, the capability to increase total green space using urban infrastructure such as iVGS is expected to carry various positive outcomes.

There is an exceptionally strong relationship between aesthetics and restoration (Deng et al., 2020). Findings of this study demonstrated that the iVGS installation elevated the aesthetic quality of the space, and this is closely related to beauty and taste. A preference for iVGS is also reflected in the significant difference in traffic before and after installation of the iVGS; in the same way, there was a higher rating for the onsite behavioural dimension (Cronbach $\alpha = 0.89$). Before the iVGS installation, more people used the north corridor, the maximum number of users per day recorded in the south corridor was 257 whereas it was 283 in the north. The reason here is that north corridor is the most direct route to the main lecture hall, and the north corridor also house student lockers, information boards, and posters. In June 2015 the iVGS was installed in the southern parallel corridor, which also leads to the lecture hall, and has rooms for lecturers and honours and PhD students (Figure 4). After the installation, the number of users in the south corridor increased and the relationship of users between the two corridors significantly changed ($r^2 = 0.8748$, $p<0.0001$, RMSE = 23.452) (Ghazalli et al., 2018). During those 5 months of data collecting there was a relative increase in the number of people using the south corridor, showing that the iVGS significantly changed the number of users in both corridors.

Positive reactions and restorative experiences are higher in a natural environment than in a built environment. However, the built environment can include natural components that allow people to perceive restorativeness in urban surroundings (Rennit & Maikov, 2015). This study has demonstrated that an iVGS may be perceived as restorative, even if it is small and located in a narrow corridor. Over time, the definition of 'natural' in an environment changes (Bratman et al., 2012) and, given the increased positive emotions evoked in this study, a small iVGS has additional value as a natural element in an urban environment, and this can bring potential restorative effects.

Limitations

Greenery can alleviate stress regardless of gender (Lottrup et al., 2013), and the iVGS provided a greenery option that was perceived as restorative by the participants. Although the results suggest that the iVGS was perceived to be restorative, according to Han (2003) these scores are not a measure of actual restorativeness because SRRS was developed to measure only potential restorative effects of a scene and, for this study, the iVGS was the 'scene'. Even though SRSS has been shown to be a reliable tool in accessing restorative value (Berto, 2014; Han, 2003), the sampling size was fairly small, and the sample may be biased towards people with an interest in the environment. This study examined only responses towards the iVGS, and data such as age and gender were not considered. For ethics approval reasons, responses were not examined based on gender, race, or ethnicity.

Due to the nature of how we respond physiologically towards the environment, this study only managed to record little information that might give further insight into how we respond physiologically towards an indoor greenery installation. Further studies could include physiological testing to validate the claims provided by the respondents. Physiological measurement methods, such as electromyography, skin conductance response, and

electroencephalography, may be useful. A longitudinal study with bigger sampling size may give more precise and significant results.

Conclusion

The central theme of this study was to explore human responses to a small iVGS. This study sought to determine whether the iVGS evoked positive responses in terms of emotions, physiology, and psychology, and whether it was rated as beneficial for restoration. This study also examined if there was a difference in responses between respondents who were present at the iVGS (onsite) and those who viewed photographs of the iVGS (online). Since these responses were both based on visual contact with the iVGS, it can be concluded that the iVGS has benefits in terms of better aesthetic and visual qualities. The restoration scores of iVGS provide tentative evidence that it refreshes cognitive energy and brings positive impact and emotions – either if present and remotely. However, more research is required to confirm this.

The iVGS used in this case study was shown to increase positive emotions and engender a sense of belonging in the respondents, which further supports studies that viewing an iVGS is perceived as restorative. There was a small yet statistically significant difference in the perceptions of those who experienced the iVGS onsite and those who only saw an image via an online survey. This difference suggests that previous research, based on virtual images and photographs, may underestimate the benefits of VGS and iVGS. Further work with bigger samples can better identify the differences and potential underestimates. However, the small number of survey respondents and indeed the small extent of the iVGS used in this study, may not have allowed further statistically significant differences in perceptions to be found.

In this case study, the SRRS was reliable in quantifying perceptions and differences. Although the three iVGS pockets each measured only 38 × 285 cm, the respondents rated the system as being restorative. This project represents a preliminary attempt to study the restorative effects of VGSs, and the outcomes may benefit designers, planners, and building owners alike. These findings present iVGS and VGS as useful urban infrastructure tools that can assist in creating a healthier living environment.

References

Abdul-Rahman, Wang, C., Rahim, A. M., Loo, S. C., & Miswan, N. (2014). Vertical greenery systems (VGS) in urban tropics. *Open House International*, *39*(4), 42–52.

Bedimo-Rung, A. L., Mowen, A. J., & Cohen, D. A. (2005). The significance of parks to physical activity and public health: a conceptual model. *American Journal of Preventive Medicine*, *28*(2), 159–168.

Berto, R. (2014). The role of nature in coping with psycho-physiological stress: a literature review on restorativeness. *Behavioral Sciences (Basel, Switzerland)*, *4*(4), 394–409. https://doi.org/10.3390/bs4040394

Bradley, M., & Lang, P. J. (1994). Measuring Emotion: The Self-Assessment Semantic Differential Manikin and the. *Journal of Behavior Therapy and Experimental Psychiatry*, *25*(I), 49–59. https://doi.org/10.1016/0005-7916(94)90063-9

Bratman, G. N., Hamilton, J. P., & Daily, G. C. (2012). The impacts of nature experience on human cognitive function and mental health. *Annals of the New York Academy of Sciences*, *1249*, 118–136. https://doi.org/10.1111/j.1749-6632.2011.06400.x

Bringslimark, T., Hartig, T., & Patil, G. G. (2009). The psychological benefits of indoor plants: A critical review of the experimental literature. *Journal of Environmental Psychology*, *29*(4), 422–433. https://doi.org/10.1016/j.jenvp.2009.05.001

Bringslimark, T., Patil, G. G., & Hartig, T. (2008). The association between indoor plants, stress, productivity and sick leave in office workers. *Acta Horticulturae*, *775*, 117–122.

Browning, M. H. E. M., Mimnaugh, K. J., van Riper, C. J., Laurent, H. K., & LaValle, S. M. (2020). Can Simulated Nature Support Mental Health? Comparing Short, Single-Doses of 360-Degree Nature Videos in Virtual Reality With the Outdoors. *Frontiers in Psychology*, *10*, 2667. https://doi.org/10.3389/fpsyg.2019.02667

Chan, S. H. M., Qiu, L., Esposito, G., & Mai, K. P. (2021). Vertical greenery buffers against stress: Evidence from psychophysiological responses in virtual reality. *Landscape and Urban Planning*, *213*, 104127. https://doi.org/10.1016/j.landurbplan.2021.104127

Chang, C. Y., & Chen, P. K. (2005). Human response to window views and indoor plants in the workplace. *HortScience*, *40*(5), 1354–1359.

Chen, Z., He, Y., & Yu, Y. (2016). Enhanced functional connectivity properties of human brains during in-situ nature experience. *PeerJ*, *4*(7), e2210. https://doi.org/10.7717/peerj.2210

Chiesura, A. (2004). The role of urban parks for the sustainable city. *Landscape and Urban Planning*, *68*(1), 129–138. https://doi.org/10.1016/j.landurbplan.2003.08.003

de Groot, W. T., & van den Born, R. J. G. (2003). Visions of nature and landscape type preferences: an exploration in The Netherlands. *Landscape and Urban Planning*, *63*(3), 127–138.

Deng, L., Luo, H., Ma, J., Huang, Z., Sun, L. X., Jiang, M. Y., Zhu, C. Y., & Li, X. (2020). Effects of integration between visual stimuli and auditory stimuli on restorative potential and aesthetic preference in urban green spaces. *Urban Forestry and Urban Greening*, *53*. https://doi.org/10.1016/j.ufug.2020.126702

Dictionary.com. (n.d.). *Meanings and Definitions of Words at Dictionary.com*. Retrieved August 4, 2020, from https://www.dictionary.com/

Dravigne, A., Waliczek, T. M., Lineberger, R. D., & Zajicek, J. M. (2008). The effect of live plants and window views of green spaces on employee perceptions of job satisfaction. *HortScience*, *43*(1), 183–187. https://doi.org/

Egea, G., Pérez-Urrestarazu, L., González-Pérez, J., Franco-Salas, A., & Fernández-Cañero, R. (2014). Lighting systems evaluation for indoor living walls. *Urban Forestry & Urban Greening*.

Evans, G. W. (2003). The Built Environment and Mental Health. *Journal of Urban Health: Bulletin of the New York Academy of Medicine*, *80*(4), 536–555. https://doi.org/10.1093/jurban/jtg063

Evensen, K. H., Raanaas, R. K., Hagerhall, C. M., Johansson, M., & Patil, G. G. (2015). Restorative Elements at the Computer Workstation: A Comparison of Live Plants and Inanimate Objects With and Without Window View. *Environment and Behavior*, *47*(3), 288–303. https://doi.org/10.1177/0013916513499584

Fernández-Bregón, N., Urrestarazu, M., & Valera, D. L. (2012). Effects of a vertical greenery system on selected thermal and sound mitigation parameters for indoor building walls. *Journal of Food, Agriculture and Environment*, *10*(3–4), 1025–1027.

Fischl, G., Varkevisser, M., Gärling, A., & Keyson, D. (2007). *The Restorative Potential of a Built Environment: Development and Evaluation of a Research-based Design* (P. Havinga, M. Lijding, & N. Meratnia, Eds.). Twente University of Technology, Enschede, The Netherlands.

Fjeld, T., Veiersted, B., Sandvik, L., Riise, G., & Levy, F. (1998). The Effect of Indoor Foliage Plants on Health and Discomfort Symptoms among Office Workers. *Indoor and Built Environment*, *7*(4), 204–209. https://doi.org/10.1159/000024583

Gatersleben, B., & Andrews, M. (2013). When walking in nature is not restorative-The role of prospect and refuge. *Health and Place*, *20*, 91–101. https://doi.org/10.1016/j.healthplace.2013.01.001

Ghazalli, A. J., Brack, C., Bai, X., & Said, I. (2018). Alterations in use of space, air quality, temperature and humidity by the presence of vertical greenery system in a building corridor. *Urban Forestry & Urban Greening*, *32*, 177–184. https://doi.org/10.1016/j.ufug.2018.04.015

Grahn, P., & Stigsdotter, U. A. (2003). Landscape planning and stress. *Urban Forestry & Urban Greening*, *2*(1), 1–18.

Grinde, B., & Patil, G. G. (2009). Biophilia: does visual contact with nature impact on health and well-being? *International Journal of Environmental Research and Public Health*, *6*(9), 2332–2343. https://doi.org/10.3390/ijerph6092332

Han, K.-T. (2003). A reliable and valid self-rating measure of the restorative quality of natural environments. *Landscape and Urban Planning*, *64*(4), 209–232. https://doi.org/10.1016/S0169-2046(02)00241-4

Han, K.-T. (2007). Responses to Six Major Terrestrial Biomes in Terms of Scenic Beauty, Preference, and Restorativeness. *Environment and Behavior*, *39*(4), 529–556. https://doi.org/10.1177/0013916506292016

Han, K.-T. (2008). Influence of Limitedly Visible Leafy Indoor Plants on the Psychology, Behavior, and Health of Students at a Junior High School in Taiwan. *Environment and Behavior*, *41*(5), 658–692. https://doi.org/10.1177/0013916508314476

Hedblom, M., Gunnarsson, B., Iravani, B., Knez, I., Schaefer, M., Thorsson, P., & Lundström, J. N. (2019). Reduction of physiological stress by urban green space in a multisensory virtual experiment. *Scientific Reports*, *9*(1), 1–11. https://doi.org/10.1038/s41598-019-46099-7

Herzog, T. R., Maguire, P., & Nebel, M. B. (2003). Assessing the restorative components of environments. *Journal of Environmental Psychology*, *23*(2), 159–170. https://doi.org/10.1016/S0272-4944(02)00113-5

Jackson, L. E. (2003). The relationship of urban design to human health and condition. *Landscape and Urban Planning*. https://doi.org/10.1016/S0169-2046(02)00230-X

Kabisch, N., Qureshi, S., & Haase, D. (2015). Human–environment interactions in urban green spaces — A systematic review of contemporary issues and prospects for future research. *Environmental Impact Assessment Review*, *50*, 25–34. https://doi.org/10.1016/j.eiar.2014.08.007

Kaplan, R., & Kaplan, S. (1989). The Experience of Nature: A Psychological Perspective. In *Cambridge University Press*. https://doi.org/10.1037/030621

Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. *Journal of Environmental Psychology*, *15*(3), 169–182.

Larsen, L., Adams, J., Deal, B., Kweon, B. S., & Tyler, E. (1998). Plants in the Workplace: The Effects of Plant Density on Productivity, Attitudes, and Perceptions. *Environment and Behavior*, *30*(3), 261–281. https://doi.org/10.1177/001391659803000301

Lee, K. E., Williams, K. J. H., Sargent, L. D., Williams, N. S. G., & Johnson, K. A. (2015). 40-second green roof views sustain attention: The role of micro-breaks in attention restoration. *Journal of Environmental Psychology*, *42*, 182–189. https://doi.org/10.1016/j.jenvp.2015.04.003

Li, D., & Sullivan, W. C. (2016). Impact of views to school landscapes on recovery from stress and mental fatigue. *Landscape and Urban Planning*, *148*, 149–158. https://doi.org/10.1016/j.landurbplan.2015.12.015

Lohr, V. I., & Pearson-Mims, C. H. (1996). Particulate matter accumulation on horizontal surfaces in interiors: influence of foliage plants. *Atmospheric Environment*, *30*(14), 2565–2568.

Lottrup, L., Grahn, P., & Stigsdotter, U. K. (2013). Workplace greenery and perceived level of stress: Benefits of access to a green outdoor environment at the workplace. *Landscape and Urban Planning*, *110*, 5–11. https://doi.org/10.1016/j.landurbplan.2012.09.002

Matusiak, B. S., & Klöckner, C. A. (2015). How we evaluate the view out through the window. *Architectural Science Review*, 1–9. https://doi.org/10.1080/00038628.2015.1032879

Mediastika, C. E., & Binarti, F. (2013). Reducing Indoor Noise Levels Using People's Perception on Greenery. *Scientific Journal of Riga Technical University. Environmental and Climate Technologies*, *11*, 19–27. https://doi.org/10.2478/rtuect-2013-0003

Montacchini, E., Tedesco, S., & Rondinone, T. (2017). Greenery for a university campus: does it affect indoor environmental quality and user well-being? *Energy Procedia*, *122*, 289–294. https://doi.org/10.1016/j.egypro.2017.07.324

Paddle, E., & Gilliland, J. (2016). Orange Is the New Green: Exploring the Restorative Capacity of Seasonal Foliage in Schoolyard Trees. *International Journal of Environmental Research and Public Health*, *13*(5), 497. https://doi.org/10.3390/ijerph13050497

Parsons, R. (1991). The potential influences of environmental perception on human health. *Journal of Environmental Psychology*, *11*(1), 1–23.

Qin, J., Zhou, X., Sun, C., Leng, H., & Lian, Z. (2013). Influence of green spaces on environmental satisfaction and physiological status of urban residents. *Urban Forestry & Urban Greening*, *12*(4), 490–497. https://doi.org/10.1016/j.ufug.2013.05.005

Raanaas, R. K., Evensen, K. H., Rich, D., Sjøstrøm, G., & Patil, G. (2011). Benefits of indoor plants on attention capacity in an office setting. *Journal of Environmental Psychology*, *31*(1), 99–105. https://doi.org/10.1016/j.jenvp.2010.11.005

Radhi, H., Assem, E., & Sharples, S. (2014). On the colours and properties of building surface materials to mitigate urban heat islands in highly productive solar regions. *Building and Environment*, *72*, 162–172. https://doi.org/10.1016/j.buildenv.2013.11.005

Rennit, P., & Maikov, K. (2015). Perceived restoration scale method turned into (used as the) evaluation tool for parks and open green spaces, using Tartu city parks as an example. *City, Territory and Architecture*, *2*(1), 6. https://doi.org/10.1186/s40410-014-0020-3

Shibata, S., & Suzuki, N. (2004). Effects of an indoor plant on creative task performance and mood. *Scandinavian Journal of Psychology*, *45*(5), 373–381. https://doi.org/10.1111/j.1467-9450.2004.00419.x

Taber, K. S. (2018). The Use of Cronbach's Alpha When Developing and Reporting Research Instruments in Science Education. *Research in Science Education*, *48*(6), 1273–1296. https://doi.org/10.1007/S11165-016-9602-2/TABLES/1

Thesaurus.com. (n.d.). *Thesaurus.com*. Retrieved September 24, 2021, from https://www.thesaurus.com/

Tyrväinen, L., Ojala, A., Korpela, K., Lanki, T., Tsunetsugu, Y., & Kagawa, T. (2014). The influence of urban green environments on stress relief measures: A field experiment. *Journal of Environmental Psychology*, *38*, 1–9. https://doi.org/10.1016/j.jenvp.2013.12.005

Ulrich, R. S. (1979). Visual landscapes and psychological well-being. *Landscape Research*, *4*(1), 17–23.

Ulrich, R. S. (1981). Natural versus urban scenes: Some Psychophysiological Effects. *Environment and Behavior*, *13*(5), 523–556. https://doi.org/10.1177/0013916581135001

Ulrich, R. S. (1983). Aesthetic and affective responses to natural environments. In *Human Behavior & Environment: Advances in Theory & Research* (Vol. 6, pp. 85–125). https://doi.org/citeulike-article-id:2206070

Ulrich, R. S. (1993). Biophilia, biophobia, and natural landscapes. In *The biophilia hypothesis* (pp. 73–137).

Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A., & Zelson, M. (1991). Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology*, *11*(3), 201–230.

van den Berg, A. E., Jorgensen, A., & Wilson, E. R. (2014). Evaluating restoration in urban green spaces: Does setting type make a difference? *Landscape and Urban Planning*, *127*, 173–181. https://doi.org/10.1016/j.landurbplan.2014.04.012

van den Berg, A. E., Koole, S. L., & van der Wulp, N. Y. (2003). Environmental preference and restoration: (How) are they related? *Journal of Environmental Psychology*, *23*(2), 135–146. https://doi.org/10.1016/S0272-4944(02)00111-1

Wang, C., Er, S.-S., & Abdul-Rahman, H. (2016). Indoor vertical greenery system in urban tropics. *Indoor and Built Environment*, *25*(2), 340–356. https://doi.org/10.1177/1420326X14550508

Weber, F., Kowarik, I., & Säumel, I. (2014). Herbaceous plants as filters: immobilization of particulates along urban street corridors. *Environmental Pollution (Barking, Essex : 1987)*, *186*, 234–240. https://doi.org/10.1016/j.envpol.2013.12.011

Weinmaster, M. (2009). Are green walls as “green” as they look? an introduction to the various technologies and ecological benefits of green walls. *Journal of Green Building*, *4*(4), 3–18.

WHO. (2021). *Urban health*. https://www.who.int/news-room/fact-sheets/detail/urban-health

Wolch, J. R., Byrne, J., & Newell, J. P. (2014). Urban green space, public health, and environmental justice: The challenge of making cities ‘just green enough.’ *Landscape and Urban Planning*, *125*, 234–244. https://doi.org/10.1016/j.landurbplan.2014.01.017

Yin, J., Arfaei, N., MacNaughton, P., Catalano, P. J., Allen, J. G., & Spengler, J. D. (2019). Effects of biophilic interventions in office on stress reaction and cognitive function: A randomized crossover study in virtual reality. *Indoor Air*, *29*(6), 1028–1039. https://doi.org/10.1111/ina.12593

Yin, J., Yuan, J., Arfaei, N., Catalano, P. J., Allen, J. G., & Spengler, J. D. (2020). Effects of biophilic indoor environment on stress and anxiety recovery: A between-subjects experiment in virtual reality. *Environment International*, *136*, 105427. https://doi.org/10.1016/j.envint.2019.105427