

How Multi-Sensory Perception Plays a Landscape Restorative Role in Adelaide's Urban Green Space

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Abstract: Urban green space is an effective psychological restoration landscape site. However, Adelaide's urban green space tends to focus on visual design but neglect non-visual senses. Sensory influence is interactive and has profound and subtle effects on tourists. The purpose of this study was to investigate the relationship between auditory, tactile, and psychological restoration of urban green space from a multi-sensory perspective. This study used quantitative research methods to investigate auditory and tactile-related landscape factors that have a positive effect on restoration. It is expected that this study will contribute to the high-quality restoration of urban green space and promote human health.

Keywords: Urban green space; Multi-sensory design; Restoration; Auditory and tactile design

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1. Introduction

Urban green space is essential for health and human well-being. It has been proven to have many functions, such as to lower blood pressure, reduce stress, and create a sense of pleasure ^[1].

A survey on Australian engagement in nature conducted by the Australian government showed that 73% of Australian adults have visited urban green space in a period of 12 months, with the Botanic Garden being the most popular (52%) ^[2]. Therefore, the demand for urban green space in Australia is extremely high.

However, currently, many designs of urban green space only focus on visual design, and with the development of the times, the satisfaction of users not only depends on visual stimulation, but also the use of multi-sensory elements in landscape design. In addition to visual experience, auditory and tactile experiences are the most basic and commonly employed methods of perception ^[3]. Therefore, they both play an essential role in the restoration of landscape.

The influence of sound on the experience of landscape design has been re-studied and has received increasing attention in recent years. For example, natural sound has been shown to have a positive effect on restoring individual attention ^[4]. Similarly, the tactile experience of a landscape is a concern for users in terms of landscape details. Exquisite details can often leave a deep impression; even a slight change can have a great impact on the overall landscape environment ^[5]. "Multi-sensory landscape" refers to a landscape based on different senses and how different senses perceive each other ^[6]. Moreover, good sensory elements can impress visitors and increase the attractiveness of a landscape, whereas bad experiences weaken the visual perception and appreciation of the landscape ^[7]. Therefore, it is crucial to explore the restoration effect of urban green space from a multi-sensory perspective and to determine the factors that play a positive restoration effect.

2. Research questions

The purpose of this research is to determine tactile- and auditory-related factors that have positive restorative effect on people.

Primary question: What are the most popular perception factors that play a positive landscape restorative role?

Sub-questions:

- (1) What is urban green space?
- (2) What are the functions of urban green space?
- (3) How does multi-sensory perception affect one's feelings?
- (4) Which landscape elements are most perceptible through auditory perception or tactile perception in urban green space?
- (5) What kind of landscape factors relating to auditory and tactile perceptions will bring negative effects to people?

3. Objectives

The purpose of this study was to investigate the auditory- and tactile-related landscape factors that play a restorative role for urban green space. Quantitative investigations were conducted to achieve this goal. Specifically, an experiment was carried out to investigate the effects of auditory landscape factors on mental recovery, and a survey was conducted to examine the effects of tactile perception on landscape factors. This investigation is beneficial for landscape designers in studying the role of non-visual factors, paying attention to how auditory and tactile factors can be used to enrich landscape design techniques and the diversity of urban green space design; for people who do not have high requirements for visual stimulation, such as the blind or those visually impaired, in order to meet their needs to use urban green space for restorative purposes; for children as they not only gain tactile sensations by walking, but also when coming into contact with objects through other parts of the body; it is especially important to meet the needs of tactile perception in children. The Urban Planning Department of the Australian government can also benefit from this research, using this research as a guide to satisfy the demand of residents for urban green space. In addition, this research will help to maximize the restorative function of urban green space through multi-sensory factors and meet the needs of residents in a variety of ways in limited green spaces.

4. Significance to the discipline

Exposure to stimuli in densely crowded cities generally requires focus, resulting in mental fatigue ^[8]. Therefore, in order to alleviate this problem, a design that allows people to recuperate is crucial ^[9].

Urban green space is an open space that allows people to breath and move freely. It is regarded as a "green lung" ^[10]. Substantial evidence has reported that nature has healing functions ^[11] and contributes to human health, mental recovery, as well as happiness.

Although 80% of the surrounding environment is perceived visually, 20% of the information is still perceived by auditory, tactile, taste, and smell senses ^[12]. The overall human experience is multi-sensory; the senses interact with each other in the environment, and different senses have their own advantage.

Nature is the largest environment where humans can gather information, and at the same time a lot of information is perceived through auditory and tactile senses ^[13]. In addition, the perception of these two senses is crucial not only for normal people, but also the visually impaired and blind ^[14].

In the past ten years, sound landscape and tactile landscape have begun to attract more and more attention. Multi-sensory design and planning of urban green space is thought to be extremely important and a necessary field to investigate. For example, Hong and Jeon pointed out that it is beneficial to introduce pleasing sounds into a polluted urban sound environment, as this can contribute to human wellbeing ^[15].

Furthermore, with regard to sound landscape, Rainbolt, Benfield, and Bell studied the effects of man-made sounds on national historical parks and claimed that whether or not the sound at a scenic spot or the noise made by an aircraft is explained, it is all negative. Similarly, Zhou also pointed out the factors that can be perceived by tactile senses in urban green spaces: floor paving, materials, and passive perceptions, such as temperature, wind, etc., using tactile experience as the focus; the entry point of designs, with more consideration of human tactile factors in these designs; the shaping of a landscape space that makes the human body more at ease ^[16]; and the contact and interaction between the human body and the landscape ^[17].

However, most researchers neglect the assessment of auditory and tactile cognitions in the restorative function. They pay more attention to studying the formation of sound landscape and tactile landscape, in addition to the relationship between visual and non-visual senses, rather than on the restorative effects of non-visual senses. In addition, the site of the investigation was not in Australia. Different research sites may have different effects on the results ^[18]. Therefore, it is necessary to focus on the non-visual senses of auditory and tactile perceptions in relation to landscape factors that play a restorative role in Adelaide's urban green space.

5. Theoretical framework and methods

Three scenic pictures (Adelaide, Adelaide Botanic Garden, and Himeji Garden in Adelaide) were selected in combination with sounds to determine the auditory-related landscape factors that have a good restorative effect on people.

Only three pictures were selected to create a relatively single visual scene, weaken the visual effect, and help subjects focus on the auditory elements. The six selected sounds were categorized into nature-related sounds (sound of water, wind, and birds singing) and man-made sounds (traffic noise, people speaking, and background music). These are common factors in urban green spaces and are directly related to the auditory sense. These factors were tested by using single playback and combined playback. The combined playback involved the use of Adobe VoCo to combine these sounds in pairs, such as the sound of water and the sound of wind, the sound of wind and people speaking, birds singing and traffic noise, etc., according to the principle of non-repetition; there were a total of 16 kinds of combined playback.

Canon EOS 3000D with EF-S 18-55mm was used to take pictures, and the three best-quality photos from each site were selected to represent the visual landscape of the site. The photos were displayed on a projector (QKK Latest Upgraded 4200 Lumens Mini Projector). The sounds used were all selected and downloaded from a website and played at 45dB through a speaker.

By combining the three photos with 22 (6 + 16) sounds using Adobe Premiere, 66 (3x22) sound-visual photo combinations were obtained. After testing each sound and photo combination, the subjects were required to fill in a form (**Figure 1**) that included the emotional, psychological, and cognition aspects of the subjects using a seven-point Likert scale, with 1 indicating strongly disagree, and 7 indicating strongly agree. After the test, the average value of each combination was determined. A high score indicated a better restorative effect of the factor. Hundred and twenty students were selected from the University of Adelaide, and the ratio of men to women was balanced.

		scale							
Emotion	I feel peaceful and less stressful	<table border="1" style="display: inline-table;"> <tr> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td> </tr> </table>	1	2	3	4	5	6	7
1	2	3	4	5	6	7			
Psychology	I feel I reduce the feeling of lonely	<table border="1" style="display: inline-table;"> <tr> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td> </tr> </table>	1	2	3	4	5	6	7
1	2	3	4	5	6	7			
Cognition	My concentration is more focused	<table border="1" style="display: inline-table;"> <tr> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td> </tr> </table>	1	2	3	4	5	6	7
1	2	3	4	5	6	7			

Figure 1. Auditory testing form

A survey was conducted to investigate tactile-related psychological restoration.

Since Adelaide Botanic Garden is located at the heart of Adelaide and is bordered by residential areas, it is an ideal location for the survey. In addition, it is surrounded by various natural elements, including shrubs and trees, with a green area of 94%. Therefore, it is an excellent location for the study.

The survey was conducted in two ways. The first was face-to-face random sampling, where questionnaires were distributed to visitors who visited the green space from 10 am to 4 pm in a week; the second was online research, where this method focused on people who had visited the Botanic Garden in the past but have not participated in face-to-face research. The purpose of the online survey was to expand the scope of the target population, so as to obtain more data and improve the credibility of the conclusion.

A five-point Likert scale was developed to measure the perceived psychological restoration. The options in the questionnaire were divided into natural elements (stepping on the lawn, walking on the soil, and feeling of temperature) and artificial elements (floor paving, seats, and fountains or pools). The subjects were required to rate the following statements: (1) “Stepping on the soft lawn gives me a pleasurable feeling”; (2) “Walking on the soil makes me feel that I am a part of nature”; (3) “The temperature here makes me feel comfortable”; (4) “The floor paving makes me feel good”; (5) “The seats here are comfortable and makes me feel relaxed”; (6) “Being in contact with water from fountains or pools makes me feel less stressed and anxious.” The statements were rated by using the five-point Likert scale, with 1 indicating strongly disagree, and 5 indicating strongly agree.

The subjects were required to fill in the questionnaire truthfully. If there was an element that had not been noticed by the subjects, the “Unnoticed” option box can be checked, and the subjects were allowed to drop the study.

All results were presented in tables and bar charts to ensure the clarity of the results.

Considering the cost of equipment and labour, the budget list is shown in **Table 1**.

Table 1. Budget list

Item	Type	Cost
camera	EOS 3000D with EF-S 18-55mm	\$239.10
projector	QKK Latest Upgraded 4200Lumens Mini Projector	\$109
speaker	Portable JBL Flip 5 Portable Bluetooth Stereo Speaker	\$145.25
printer (for questionnaire)	Epson Expression Home XP-3100 Print	\$99.16
The salary of the assistant who issued the questionnaire	7 days in all	\$400
Paid websites download sound	6 typers of sound	\$30
Total		\$1,022.51

The research timeline is shown in **Figure 2**.

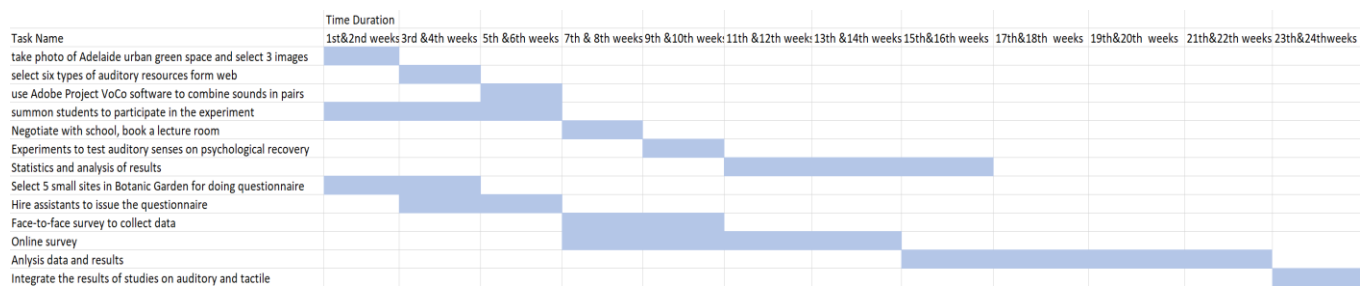


Figure 2. Research timeline

6. Skills training and professional development

Adobe VoCo is needed to synthesize sounds, while Adobe Premiere is required for combining pictures and sounds. Before starting the research, it is necessary to learn literal scale systematically and set accurate and appropriate options as well as corresponding values.

Disclosure statement

The authors declare no conflict of interest.

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