

Study on Method of Measurement for Stress-Easing Viewing Urban Greenery

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ABSTRACT

When people recognize a landscape, they first need to see it for a definite period time. This study clarified the way green space in a landscape is recognized using eye movement analysis, and evaluated the possibility for quantifying stress-reducing effects of seeing a landscape. The results of the experiments on eye movement analysis suggest that the way of recognizing green space in a landscape may depend on a ratio of the amount of scenic greenery in a landscape, color and greenery layout. Especially, this study also suggests that the possibility of the greenery layout guiding eye movement could be verified by conducting a study on planting patterns. In addition, the results of the experiments for quantifying stress-reducing substances found that it is likely that a green space in an urban area has stress-reducing effects.

Key Words: Greenery Space, Way of Recognition, Eye Movement Analysis, Urban Greenery, Stress

I. Introduction

Nowadays, living in what is called a stressful society, creating an urban environment where a healthy life can be enjoyed is expected. The healing effect of plants in green spaces, as one of the various effects of urban greenery, has drawn attention, but the mechanism of the effects is not yet fully understood. The number of studies which make an effort to clarify the relationship between plants and human beings in terms of physiological aspects has gradually increased (Yatagai *et al.*, 2003; Sawano, 1994).

On the other hand, many studies have described how human psychological functions are affected by a change in visual stimulation. In other words, they are affected by seeing different landscape scenes. In the psychological field, though not dealing with greenery landscapes, Morita, H. and Morita, M. (1998) have studied the order of ease of recognition of the shapes of people in terms of psychological and visual aspects. They also examined the difference in recognition when using color. These studies led us to think it reasonable that human psychological and psychological functions would also be affected

by differences in the visibility of green in urban areas and different ways of urban greenery contact. For example, Lohr *et al.* (1996) have reported on a relationship between the shape of a tree and human mental states. Provided that human psychological changes observed when people see a greenery landscape in an urban area can be described with the help of a particular greenery landscape, or a certain type of greenery layout, there is the possibility that greenery design may increase healing effects on people.

Therefore, this study evaluated the method for verifying human psychological functions which are affected by seeing greenery landscapes in urban areas. In particular, the method for verifying a change in psychological functions was evaluated from the medical point of view by using stress reduction as an indicator.

II. Methods

In this study, two experiments were carried out in order to clarify how human psychology was affected by seeing a landscape photo, and two types of indicators were used: one

was the change in stress-reacting substance, and the other was the eye movement.

1. Comparison between Urban Landscapes and Greenery Landscapes

In an urban area, there are artificial landscapes such as business complexes where trees or greenery can hardly be seen, and natural landscapes such as urban parks which include open spaces with trees. It is said that people can reduce their stress resulting from social activities when they see a natural landscape. Therefore, how much stress was reduced by looking at landscape photos with different layouts of trees was examined.

Specifically, landscape photos with different views of scenic greenery taken in urban areas, were used with ratings to quantify changes in stress in a laboratory experiment. Photos of a landscape consisting mostly of a business complex served as the control group. The control group had no more than a 20% view ratio of scenic greenery. Landscapes full of green,

including an urban park and urban greenery were also selected for the study, and they had a greater than 20% view ratio of scenic greenery(Figure 1). Stress was quantified by using these photos according to the procedure shown in Figure 2.

Stress measurement was conducted on all subjects(12 persons total) in the same laboratory. First, saliva samples were collected from the subjects to measure salivary cortisol and amylase to determine the level of stress at rest. Next, subjects underwent the Kraepelin Test, in which simple calculations are done in succession, for 15 minutes to induce stress. After the Kraepelin Test, the second set of saliva samples was collected from the subjects. Then, one group of subjects viewed slides of a greenery landscape for 5 minutes, and the other group viewed an artificial landscape for 5 minutes. The slides were projected to the screen(2×1.5m). After viewing the landscapes, all the subjects did the Kraepelin Test again for 15 minutes in order to induce stress. Upon completion, the third set of saliva samples was collected. Finally, each group viewed the same slides as they had viewed prior to the third collection for 10 minutes, then the fourth set of saliva samples was collected. Simple and quick salivary cortisol test kits(Enzyme Immunoassay Kit) were used to measure stress. Nipro's COCORO METER was used to measure salivary amylase, which is increasingly considered to be one of stress-reacting substance.

Table.1. Procedure of stress measurement

1. Explanation after all subjects sit in a same room
2. First collecting of saliva after 15minutes sitting(cortisol and amylase)
3. Stress(Kraepelin test: 15 minutes)
4. Second collecting of saliva after 15minutes stress(amylase) ②
5. Viewing slides 5minutes
6. Stress(Kraepelin test: 15minutes)
7. Third collecting of saliva(cortisol and amylase) ③
8. Viewing slides 10minutes
9. Fourth collecting of saliva(cortisol and amylase) ④
10. Finish

*: cortisol=12persons, amylase=9persons(total)

2. Measurement of Stress-Reducing Effects using a View Ratio of Scenic Greenery, Color and Layout

Green spaces in an urban area, where human activities are

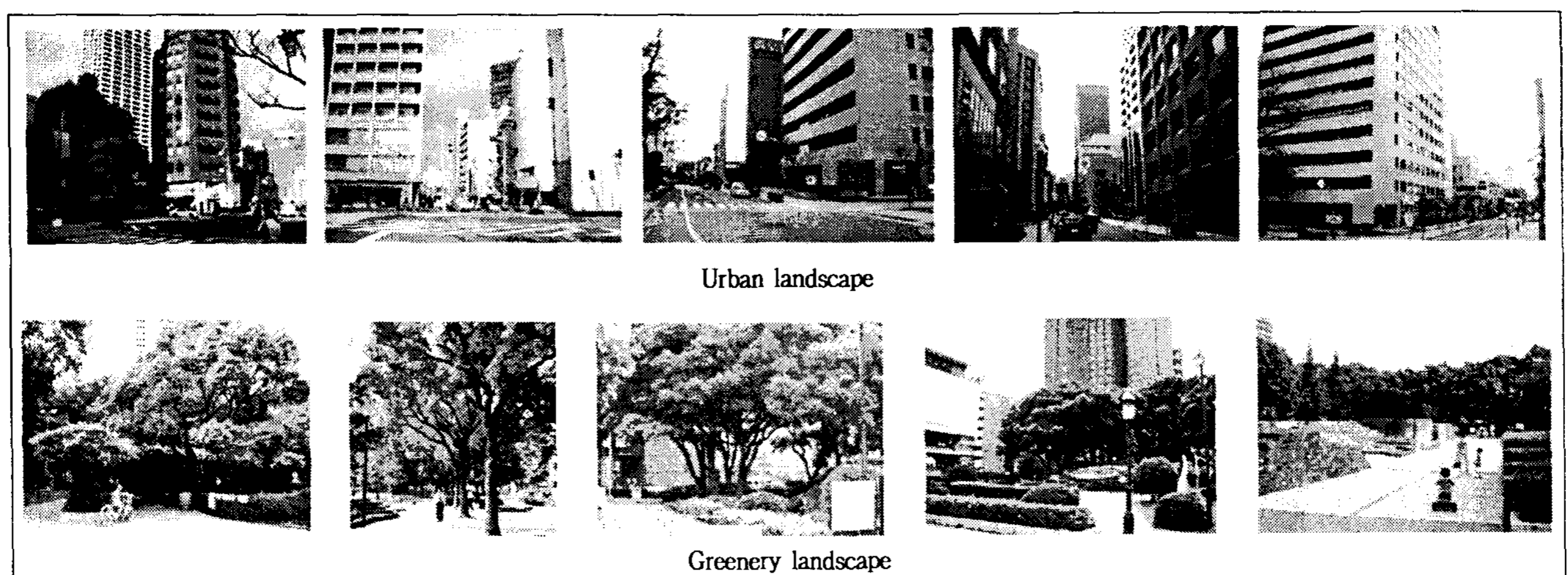


Figure 1. The photos for viewing after stress

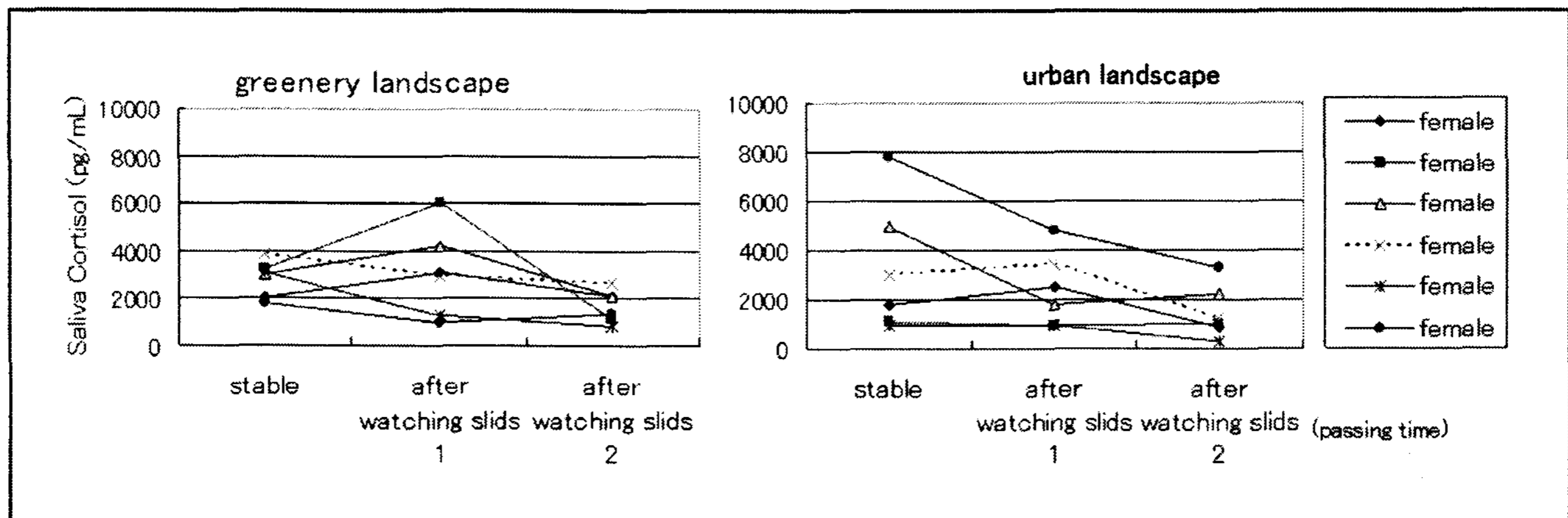


Figure 2. The level of saliva cortisol

dynamic, create a variety of landscapes. Each landscape has its own view ratio of scenic greenery, color and greenery layout, and each person experiences a different mental condition when viewing a landscape. In the experiment, three factors, or the view ratio of scenic greenery (the amount of greenery seen in an urban area) and color (visibility in green spaces) were used as environmental components, and the comparative experiments were carried out with a pair of photos with an opposing factor. Specifically, the landscape photos were displayed on screen for more than 20 seconds in the laboratory, and while subjects wearing an Eye Mark Recorder (EMR-8, NAC) on their heads viewed the photos, eye movement was traced and recorded to collect data. It is important that subjects view the photos closely for a certain amount of time in order to recognize the green space. Hori *et al.* (1982) have studied the trace of a visual line and a focal point by using planting design, and have reported that the time needed to recognize green spaces was 30 seconds. Kohama *et al.* (1996) have described that only a few seconds are needed until people can recognize graphic forms. It can be assumed, therefore, that the time needed to recognize a greenery landscape differs depending on the components of a landscape. In this study, as was mentioned before, the time for recording data was set for more than 20 seconds. The subjects consisted of five students who have received specialist training in landscape design, and the study was carried out in February in 2006.

For analyzing the data, analysis software attached to an Eye Mark Recorder was used, and the trace of a eye movement, a focal point, and the amount of blinking while observing were analyzed. The reason why the amount of

blinking was added to eye movement and a focal point is as follows.

When seeing a landscape, people always blink their eyes. The amount of blinking within a certain amount of time shows the level of stress being felt. The Mechanical Social System Foundation (2004) has reported that the amount of blinking shows human mental conditions. There are an increasing number of studies that have reported healing effects of eye movement. The amount of blinking tends to be higher when people have a stable mental condition, while it tends to be lower when people feel nervous. Based on the results of the existing studies, the time for viewing a landscape was set at 20 seconds.

In a series of experiments, the trace of visual lines was analyzed with the data collected during the initial 10 seconds of viewing a landscape, and the amount of blinking was analyzed using the data collected during the 20 seconds of landscape viewing. In other words, the subjects saw each landscape photo for about 20 seconds, and the data collected for the first 10 seconds and for the full 20 seconds was used for analysis. Figure 4, 5, 6 is the landscape photo used for eye movement analysis.

III. Results and Discussion

1. Difference in Recognition between Urban Landscapes and Greenery Landscapes

The results of experiments that measured stress-reducing effects of urban and greenery landscapes with a different visual ratio of scenic greenery are shown in Figures 2 and 3.

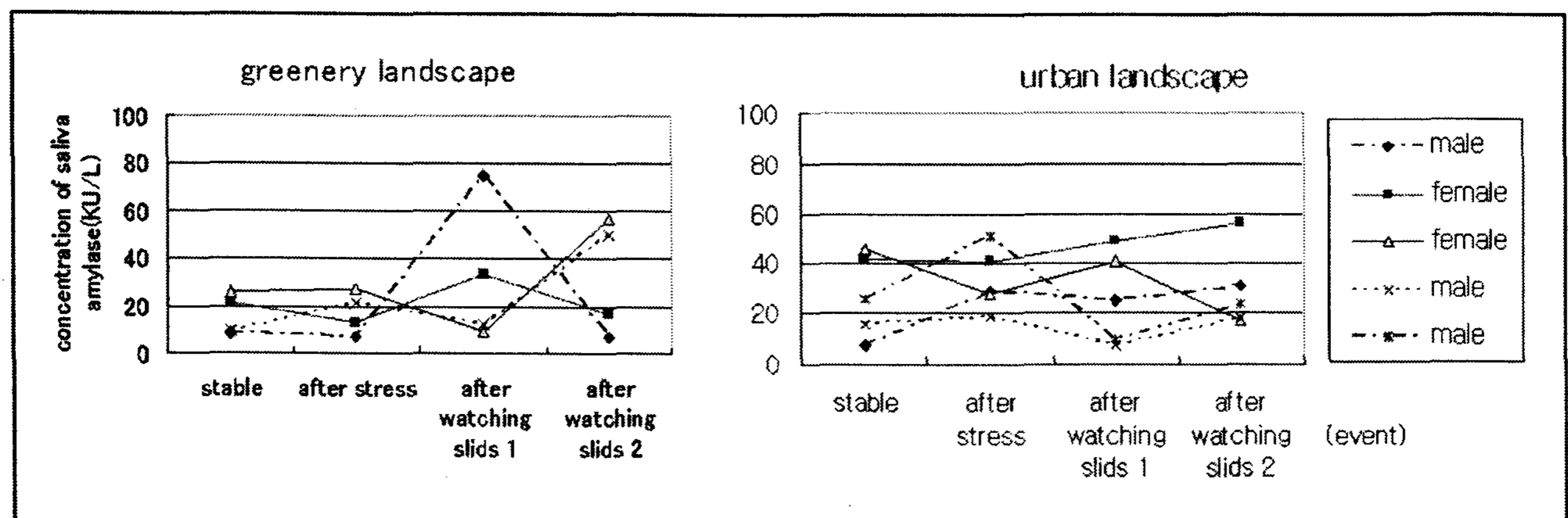


Figure 3. The level of saliva amylase

Figure 2 show that levels of salivary cortisol at rest differ largely depending on the subject. Levels of salivary cortisol observed after the experiment, or after the subjects underwent stress and then viewed landscape photos for 10 minutes tended to be lower than the levels before the experiment. A noted difference of these levels was not observed between subjects who saw a greenery landscape and those who saw an urban landscape. Some subjects showed inconsistent changes in salivary levels: they had temporarily increased levels of salivary cortisol after receiving the first stress and viewing the first greenery landscapes, and had lower levels of salivary cortisol after viewing the last greenery landscapes for 10 minutes. The results indicate that, in the experiment on stress-reducing effects with salivary cortisol used as an indicator, clear differences can not be observed between the groups, although temporary stress-reducing effects were expected after seeing both greenery and urban landscapes. These results also suggest that greenery landscapes may have stress-reducing effects on temporarily applied stress. The results of the experiment on stress-reducing effects with salivary amylase used as an indicator are shown in Figure 3. It indicates that some subjects had temporarily increased levels of salivary amylase, and others had temporarily decreased levels after viewing the first greenery landscapes. After viewing the last landscape photos for 10 minutes, two subjects had lower levels, and two other subjects had higher ones. On the other hand, the results of subjects who saw urban landscapes, as shown in Figure 3, demonstrate that levels of salivary amylase measured after viewing the last landscapes were higher than those measured after the previous landscapes in four subjects. These results suggest that

greenery landscapes may have potential to reduce stress for a short time.

2. Comparison in Recognition of Green Spaces under Different Green Conditions

1) Recognition of green spaces with a different view ratio of scenic greenery

Based on the results of the comparison using a landscape photo which shows trees in the front of buildings in an urban business complex and has a high view ratio of scenic greenery, and another which was taken after the trees' leaves had fallen in winter so the buildings can be completely seen through them and has a lower view ratio, it is indicated that eye movement tend to move along planting sites when subjects view a landscape with a higher view ratio (Figure 4, left). On the other hand, when there is a lower view ratio, eye movement gathered to the branches of defoliating trees or moved sharply (Figure 4, right). The amount of blinking averaged 4.5 blinks for all five subjects who saw both urban landscapes for 10 seconds. On the other hand, the amount of blinking was eight blinks for the subjects who viewed an urban landscape with a higher view ratio of scenic greenery for 20 seconds, while it was 9.75 (the average for four subjects) in the subjects who viewed an urban landscape with a lower view ratio of scenic greenery, and little difference was noted (Table 2). It is generally believed that people tend to blink their eyes less frequently under stressful circumstances. Therefore, based on these results, it can be thought that subjects will focus their gaze in effort to have a clearer view of the landscape.

Table 2. Amount of blinking each photos

scene variety	Number of blinking average			
	10second	number of sample	20second	number of sample
much greenery	4.60	5	8.00	5
small greenery	4.50	4	9.75	4
many colors	4.33	3	7.20	5
few colors	5.25	4	10.20	5



Figure 4. Difference of eye movement viewing different density of greenery

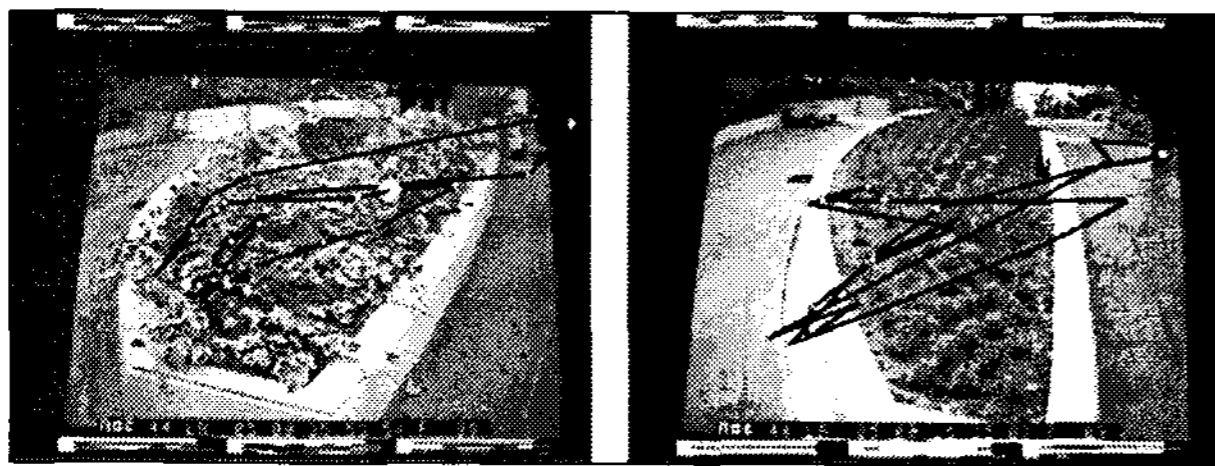


Figure 5. Difference of eye movement viewing different colors of greenery

2) Recognition of green spaces with different colors

As for green spaces with different colors, the presence of accentuated, brightly-colored flowers in green spaces, as shown in Figure 5, left photo, attracted more eye movement for a longer time, while green spaces without full-blown flowers, for example ones that had just been planted, drew fewer visual lines, and even when they drew visual lines, the attention time was shorter (Figure 5, right). The results also show that the amount of blinking was lower when subjects saw an urban landscape with many colorful flowers (Table 2). Based on these results, it can be thought that the presence of flowers with a in green spaces guides variety of color eye movement there, and fixes them for a longer time.

IV. Conclusions

The results of the comparative experiments using greenery and urban landscapes suggest that there is a possibility that greenery landscapes have stress-reducing effects even when

people view them for a short time. In addition, the results of the comparative experiment on greenery layouts suggest that recognition of green spaces may depend on a vision ratio of scenic greenery, trees, and color in green spaces. Especially, the longer people view a landscape, the more often they blink their eyes. This suggests that viewing a landscape for a longer time may change the way of recognizing it.

Thus, it can be considered that there is the possibility the stress-reducing effects of greenery landscapes can be quantified by using some indicators. One of the indicators is measurement of levels of stress-reacting substances by using medical tests. Another indicator is observation of the amount of blinking using an Eye Mark Recorder. The experiments in this study were all carried out in the laboratory, using landscape photos. Further studies need to be conducted outside in order to improve the accuracy of experiment verification, and to add more pieces of evidence to the existing ones. Additional experiment verification would allow more effective study of greenery layouts in open spaces.

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