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Thermal Comfort and Outdoor Activity in Japanese Urban Public Places

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Subjective thermal comfort and outdoor activity in a park and a square in a satellite city northeast of Tokyo were investigated through structured interviews, observations, and comprehensive micrometeorological measurements. Results showed that the park was on an average 1.1°C cooler than the square. The relatively warmer thermal conditions in the square in comparison to the park resulted in a heat load of greater intensity for humans in the square. In general, there was a low relation between the thermal environment and the use of the two places in terms of total attendance. However, the use of the park was influenced more by the thermal conditions than by the use of the square, which can mainly be attributed to the different functions of the two places. Finally, examples of the differences between the use of the sun, the attitudes toward it, and outdoor exposure in Japan and Sweden are highlighted and discussed.

Keywords: *thermal comfort; physiological equivalent temperature; attitude; use; square; park*

Introduction

The outdoor environment is an important social, public place. Many recreational activities—restaurants and cafes of considerable commercial value—are

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taking advantage of the outdoor environment. Although weather is a limiting factor for several outdoor activities, the weather is a natural resource of enormous economic significance from a recreational and touristic perspective (Spagnolo & de Dear, 2003).

Recently, thermal comfort in outdoor settings has received increased research attention. Some studies have focused on spatial variations of thermal comfort within urban areas (e.g., Barradas, 1991; Matzarakis, Mayer, & Iziomon, 1999; Mayer & Höppe, 1987; Mertens, 1999; Svensson, Thorsson, & Lindqvist, 2003). Others have tried to evaluate thermal comfort in relation to outdoor activity in different public places, such as plazas, squares, streets, and parks (Eliasson, Knez, Westerberg, Thorsson, & Lindberg, in press; Gehl, 1968, 1996; Li, 1994; Lindberg, Thorsson, & Eliasson, in press; Nagara, Shimoda, & Mizuno, 1996; Nasar & Yurdakul, 1990; Nikolopoulou, Baker, & Steemers, 2001; Thorsson, 2003; Zacharias, Stathopoulos, & Hanqing, 2001). The general conclusions are that large, spatial variations of thermal conditions occur within the urban area and that different thermal conditions are related to different usage of public places. The weather is important not only for the quantity but also for the quality of outdoor activities (Westerberg, 2004).

Apart from the thermal environment, several other parameters have been shown to be of significance to the subjective assessment and satisfaction of the outdoor environment, such as context (design, function), environmental interaction (lighting, acoustics, air quality), and psychological parameters (expectations, experience, time of exposure, perceived control, environmental stimulation; e.g., de Freitas, 1997; Höppe & Seidl, 1991; Nikolopoulou & Steemers, 2003; Nikolopoulou et al., 2001; Spagnolo & de Dear, 2003; Thorsson, Lindqvist, & Lindqvist, 2004). It has also been shown that heat and cold stress have a negative influence on people's emotional state (Bell & Baron, 1977; Cohn, 1993) and that people's perception of beauty is influenced by weather and climate (Eliasson et al., in press; Knez, 2003).

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Despite the complexity of issues involved in outdoor thermal comfort, it is necessary to increase our knowledge of these issues to provide better guidance in urban planning and design. By improving the physical and climatic aspects of urban places, it is possible to revitalize parts of the city and improve the quality of life provided by buildings.

Previous studies on the thermal environment in outdoor urban places and the implications for the people using them have mainly focused on European and North American cities (Eliasson et al., in press; Gehl, 1968, 1996; Lindberg et al., in press; Nasar & Yurdakul, 1990; Li, 1994; Nikolopoulou et al., 2001; Thorsson, 2003; Thorsson et al., 2004; Zacharias et al., 2001). In this study, two outdoor public places—a park and a square in the satellite city of Tokyo, Japan—are investigated using structured interviews, observations, and comprehensive micrometeorological measurements. Compared with most European and North American small- or medium-sized cities, Japanese cities generally have a more dense building structure, with the parks being smaller and more scarce.

This study is part of the large Swedish multidisciplinary Urban Climate Spaces research project that integrates architecture, psychology, and climatology (Eliasson et al., in press). The aim of the Urban Climate Spaces project is to investigate the effects of the microclimate as well as to study how urban public places are appreciated and used. The results will then be applied to urban design. This article presents results from a study which was carried out in collaboration with a research group in Japan, the purpose of which was to study the use and levels of activity in Japanese urban places. Spatial and temporal variations in the thermal environment and its influence on usage and subjective perception were investigated. The relation of the people to the places, the main reason for using them, and the time spent in them were studied to obtain an appreciation of the function of the places. Further differences in attitudes toward the sun and the amount of time spent outdoors in Japan and Sweden were highlighted and discussed.

Study Area

Field surveys were performed in the city of Matsudo (35º 78′ N, 139º 90′ E), which is located in the northwestern part of the Chiba region in Japan, 20 km northeast of central Tokyo (Figure 1). Since the 1960s, Matsudo has rapidly grown as one of the many satellite cities in Tokyo, and today, the city has a population of about 470,000.

The Tokyo area has a temperate climate, with warm, humid summers and mild, dry winters. Figure 2 shows the daily mean, maximum, and minimum air temperatures (T_a) and the number of days with $T_a \geq 30$°C in Tokyo, Japan.

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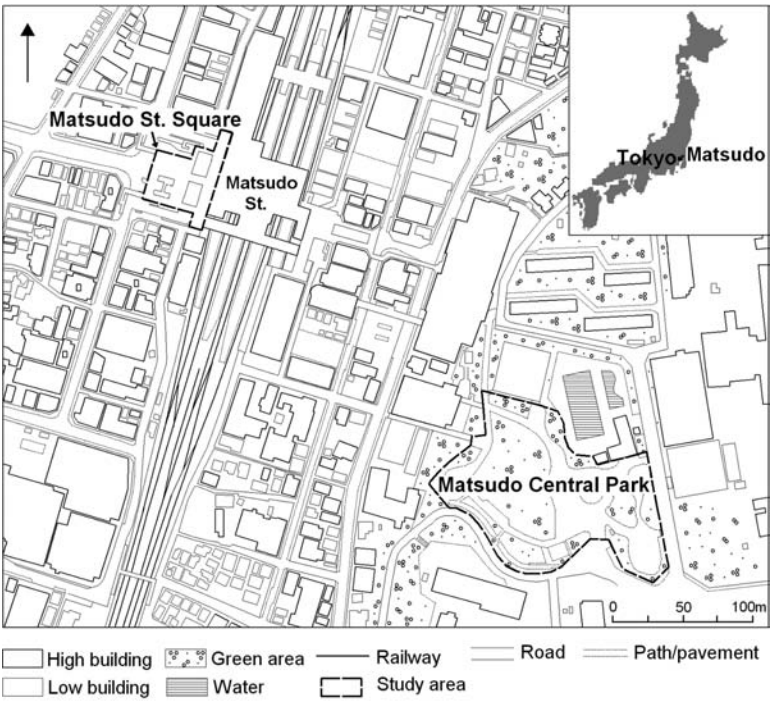
Figure 1
Map Showing Central Matsudo (35º 78´ N, 139º 90´ E), Japan



Note: St. = Station.

Two outdoor public places—a park (Matsudo Central Park) and a square (Matsudo Station Square) within the city center of Matsudo (see Figure 1)—were selected for case studies. The designated areas typically represent examples of two different outdoor public places in a medium-sized Japanese city.

Matsudo Station Square

Two public squares are located at the west and east of Matsudo Station. The squares are raised one level above ground, providing a vital and pleasant pedestrian link between the station and the surrounding buildings away from the traffic. The two squares also act as key gathering points in central Matsudo. This type of construction around railway stations is common in many modern Japanese cities.

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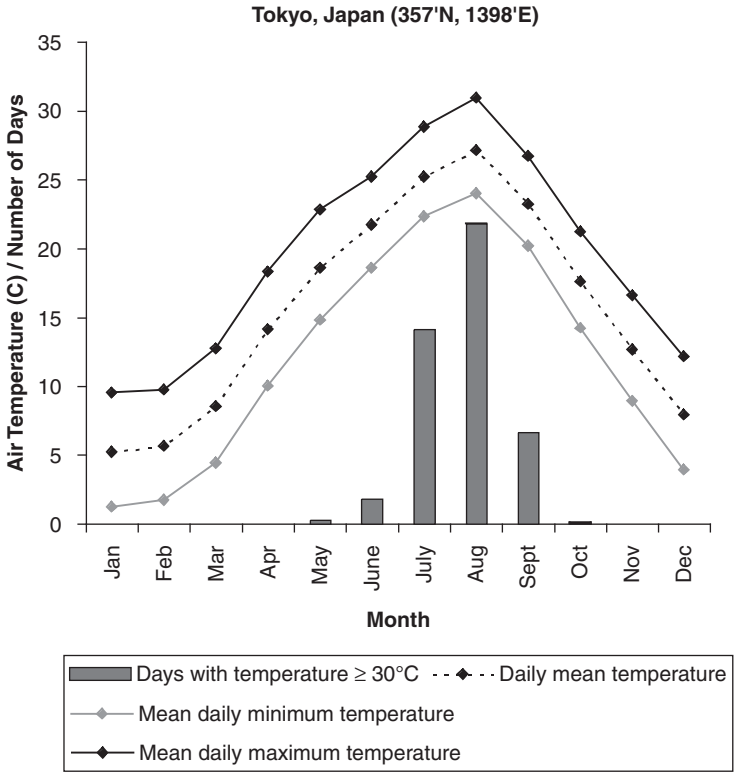
Figure 2
Mean Daily Mean, Maximum, and Minimum Air Temperatures (T_a) and Days With $T_a \geq 30°C$ in Tokyo, Japan (Normal for the Period 1971 to 2000, Japan Meteorological Agency)



Note: The two study areas (Matsudo Station Square and Matsudo Central Park) are marked with a dashed black line.

The west square, marked with a dashed black line in Figure 1, was selected for this study. Photographs of the designated area are shown in Figure 3. The square is made of light-colored clinkers. It has a spatial extension of approximately 50 × 40 m with a 0.4-m wall surrounding the square on which people sit. The square is laid without trees, with little shading available during the midday.

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Figure 3
Photographs Showing Matsudo Station Square in Matsudo, Japan



Matsudo Central Park

Matsudo Central Park is located about 250 m east of Matsudo Station as shown in Figure 1. Photographs of the park are shown in Figure 4. The park, which is typically Japanese in design, can be divided into three main parts: an open grass lawn, a forested part, and a playground. An outdoor swimming pool and two tennis courts are connected to the park. It has several benches, both under trees and in the open, which offer a variety of sunny and shaded spaces for people to sit. The study area, marked with a black dashed line in Figure 1, covers an area of about 21,000 m^2.

Method

Field surveys were conducted on March 12 through 24, 2004 and May 16 through 26, 2005. In March, the mean daily maximum temperature in Tokyo is 12.7°C, and in May, the mean daily maximum temperature is 22.7°C as indicated in Figure 2. March represents the transition from winter to spring, and May represents the transition from spring to summer.

The field surveys took place between 11 a.m. and 3 p.m. on weekdays. At this time of the day, both the T_a and solar radiation reach their daily maximum, and both places have the most visitors. Field surveys were only performed on days without precipitation. Days on which precipitation occurred were excluded from the analysis. The structured interviews, unobtrusive observations of the naturally occurring behavior, and micrometeorological measurements were conducted at the two urban places simultaneously.

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Figure 4
Photographs Showing Matsudo Central Park in Matsudo, Japan



Structured Interviews

People's thermal perception, climatic and aesthetic preferences, and emotional state were investigated through structured interviews. The interviews were performed in Japanese and covered questions about (a) age, clothing, living, or working in the city; (b) the reason(s) for being in the places; (c) time spent outdoors and in the places; and (d) the assessment of the microclimate and the aesthetic qualities of the place and emotional state. A final question aimed at assessing the attitude to urban outdoor exposure was also included, as shown in Figure 5. The subjects were asked to report their aesthetic and climatic preferences on a 5-degree scale and their thermal perception, according to a 9-point scale: *very cold*, *cold*, *cool*, *slightly cool*, *comfortable*, *slightly warm*, *warm*, *hot*, and *very hot*. Each interview took an average of 5 min to complete. Approximately, 20 to 40 interviews were conducted daily in each area. This article focuses on Questions 1 through 3, as well as parts of Question 6 that assess thermal perception (Figure 5). Questions concerning the aesthetic qualities of the places and people's emotional state are discussed in Knez and Thorsson (2006).

Observations of Use and Outdoor Activity

The usage and outdoor activity within the designated places were investigated by unobtrusive observations for every 20 min, according to a fixed time schedule. A total of 11 observations were performed each day. The number of people sitting and standing in the sun, in addition to visible qualifications

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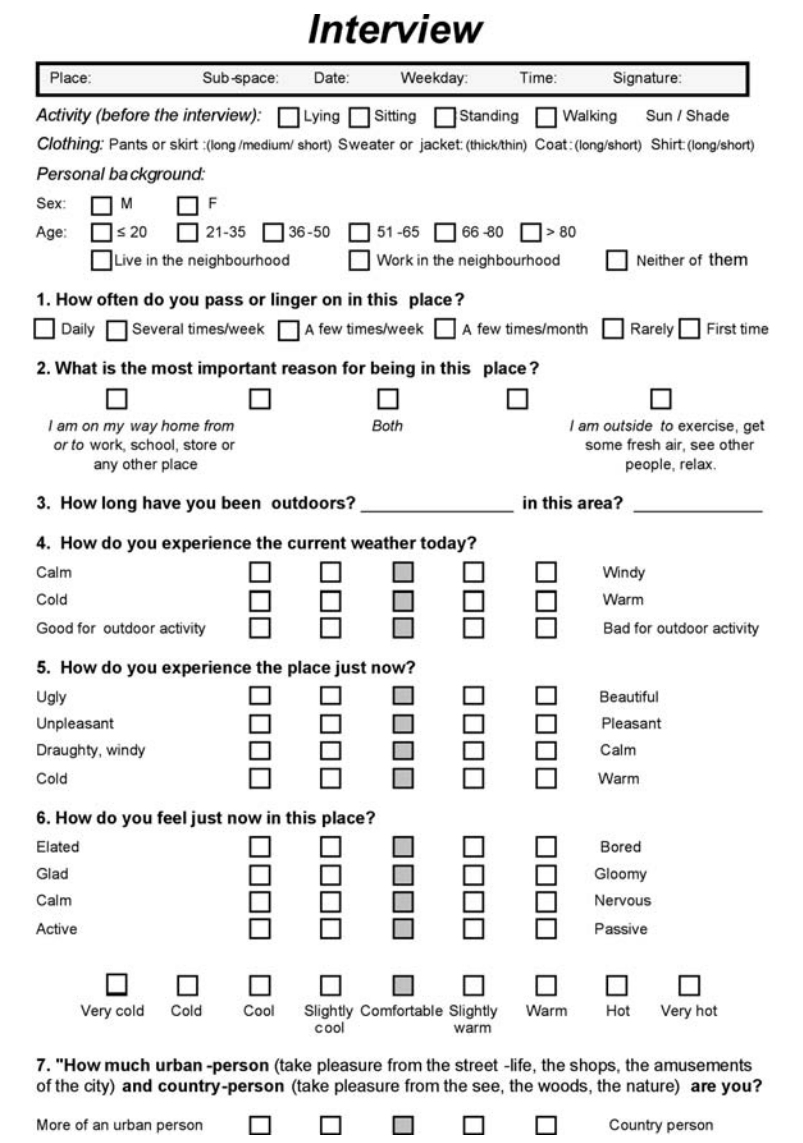
Figure 5
Structured Interview Used in This Project



Interview

Place: Sub-space: Date: Weekday: Time: Signature:

Activity (before the interview): ☐ Lying ☐ Sitting ☐ Standing ☐ Walking Sun / Shade

Clothing: Pants or skirt :(long /medium/ short) Sweater or jacket: (thick/thin) Coat : (long/short) Shirt: (long/short)

Personal background:

Sex: ☐ M ☐ F

Age: ☐ ≤ 20 ☐ 21-35 ☐ 36-50 ☐ 51-65 ☐ 66-80 ☐ > 80

☐ Live in the neighbourhood ☐ Work in the neighbourhood ☐ Neither of them

1. How often do you pass or linger on in this place?

☐ Daily ☐ Several times/week ☐ A few times/week ☐ A few times/month ☐ Rarely ☐ First time

2. What is the most important reason for being in this place?

☐ *I am on my way home from or to* work, school, store or any other place ☐ ☐ *Both* ☐ ☐ *I am outside to* exercise, get some fresh air, see other people, relax.

3. How long have you been outdoors? _____ **in this area?** _____

4. How do you experience the current weather today?

Calm	☐	☐	☐	☐	☐	Windy
Cold	☐	☐	☐	☐	☐	Warm
Good for outdoor activity	☐	☐	☐	☐	☐	Bad for outdoor activity

5. How do you experience the place just now?

Ugly	☐	☐	☐	☐	☐	Beautiful
Unpleasant	☐	☐	☐	☐	☐	Pleasant
Draughty, windy	☐	☐	☐	☐	☐	Calm
Cold	☐	☐	☐	☐	☐	Warm

6. How do you feel just now in this place?

Elated	☐	☐	☐	☐	☐	Bored
Glad	☐	☐	☐	☐	☐	Gloomy
Calm	☐	☐	☐	☐	☐	Nervous
Active	☐	☐	☐	☐	☐	Passive

☐	☐	☐	☐	☐	☐	☐	☐	☐
Very cold	Cold	Cool	Slightly cool	Comfortable	Slightly warm	Warm	Hot	Very hot

7. "How much urban -person (take pleasure from the street -life, the shops, the amusements of the city) **and country-person** (take pleasure from the see, the woods, the nature) **are you?**

More of an urban person	☐	☐	☐	☐	☐	Country person

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such as eating and drinking, talking and associating, reading, playing and exercising, talking on mobile telephones, and smoking were observed within the different subspaces, according to an observation protocol. The number of people passing through the places was also noted.

Micrometeorological Measurements

Two meteorological stations, equipped according to Table 1, were used to measure the micrometeorological factors: T_a, globe temperature, surface temperature, relative humidity, wind speed, incoming short-wave radiation, and incoming long-wave radiation. A photograph of the meteorological station is shown in Figure 6. The measurement of height was 1.1 m, corresponding to the average height of the center of gravity for adults (Mayer & Höppe, 1987), excluding the wind measurement consideration. Wind speed was measured at a height of 2 m. It was later extrapolated down to 1.1 m using Sverdrup's power law. Data were sampled for every minute and stored in data loggers (Campbell CR 10). The meteorological stations were placed at the most open point in each place so that the stations would be in the sun during the entire period of the field survey.

Physiological Equivalent Temperature

The thermal environment was investigated using the T_a and the physiological equivalent temperature (PET). The PET, which is based on the Munich Energy balance Model for Individuals (Höppe, 1993), is defined as the T_a at which the energy balance for the assumed indoor condition is balanced with the same mean skin temperature and sweat rate as calculated for the actual outdoor condition (Mayer & Höppe, 1987). The idea behind PET is to transfer the actual thermal conditions into an equivalent indoor environment in which the same thermal sensation is expected (Mayer & Höppe, 1987). A PET value around 20°C is characterized as comfortable. Higher values indicate increasing probability of heat stress, and lower values indicate increasing probability of cold stress (see Table 2).

The PET was calculated using the PC application RayMan (Matzarakis, 2002; Matzarakis, Rutz, & Mayer, 2000). RayMan, developed in accordance with guideline 3787 of the German engineering society (VDI, 1998), calculates the radiation fluxes within urban structures based on certain parameters, including T_a, air humidity, degree of cloud cover, air transparency, time of day and year, albedo of the surrounding surfaces, and their solid angle proportions (VDI, 1994).

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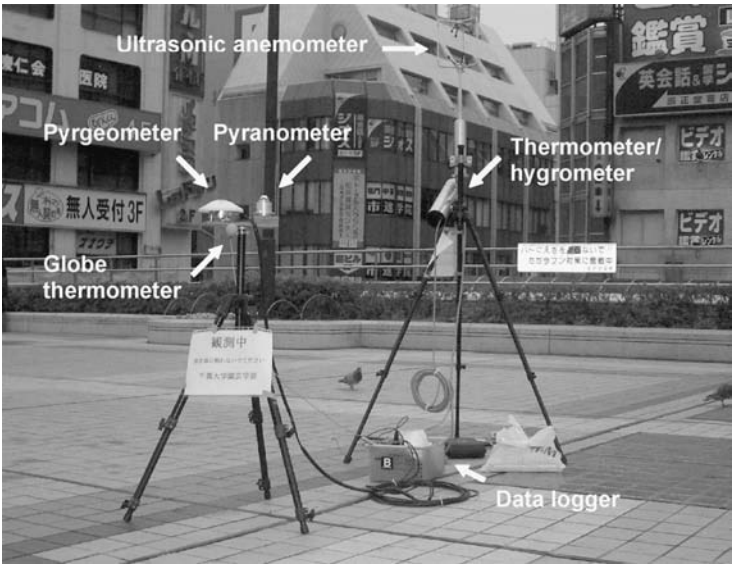
Table 1
Measured Meteorological Factors, Instruments, and Accuracy

Factor	Instrument	Accuracy
T_a	Rotronic YA-100	< ±0.2°C
T_g	AMR Pt100 PK 24	±0.3°C at 0°C
T_s	AmiR 7811-20	±2°C
RH	Rotronic YA-100	< ±1%
W	Gill Inst. Ultrasonic	1.5% RMS
S↓	Kipp & Zonen CM3	
L↓	Kipp & Zonen CG1	

T_a = air temperature; T_g = globe temperature; T_s = surface temperature; RH = relative humidity; W = wind speed; $S\downarrow$ = incoming short-wave radiation; $L\downarrow$ = incoming long-wave radiation.

Figure 6
Photograph Showing the Setup of Meteorological Instruments



Results

The results of the meteorological and behavioral (interviews and observations) data collection during 9 days in March 2004 (winter/spring) and

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8 days in May 2005 (spring/summer) are presented below. A total of 1,142 people were interviewed (469 in March 2004 and 673 in May 2005) of which 541 were interviewed in the park and 601 were interviewed in the square. The majority (74.8%) of the interviewees were between 21 and 65 years of age and of which 51.6% were women and 48.9% were men. In addition, the usage and levels of outdoor activity within these places were investigated through 337 observations.

Thermal Environment—Spatial Variations

Figure 7 shows the calculated 10-min mean values of T_a and PET at Matsudo Station Square and Matsudo Central Park between 11 a.m. and 3 p.m. for the two measurement periods. As shown, the park is generally cooler than the square. During the measurement campaign, T_a was on an average of 1.1°C lower in the park than in the square, with a maximum T_a difference of 3.0°C being recorded (Figure 7a). The calculated PET values show even larger variations, with a mean difference of 1.6°C between the square and the park (Figure 7b).

Compared with the measured T_a values, the calculated PET values were roughly 5.7°C higher in the park and 5.5°C higher in the square.

Thermal Perception

The interviewees were asked to report their thermal perceptions, according to a 9-point scale as shown in Table 2. This was then compared with that assessed by the PET index. Figure 8a shows the percentage frequency distribution for the thermal perception of the interviewees and the calculated PET at the Matsudo Station Square. About 20.3% of the interviewees felt that the thermal conditions in the square were comfortable; 23.7% estimated the conditions to be slightly cool, cool, cold, or very cold; and 55.9% felt as slightly warm, warm, hot, or very hot. Although there was a discrepancy in the percentage frequency between the thermal perception of the interviewees and the calculated PET, the PET distribution was also skewed toward the warm zone. Figure 8b shows the corresponding distribution in Matsudo Central Park. In the park, 31.0% of the interviewees assessed the thermal conditions as being comfortable, 27.9% as slightly cool, cool, cold, or very cold; and 41.2% as slightly warm, warm, or hot. The calculated PET values show that the heat load for humans was of greater intensity in the square in comparison to the park. This was also reflected in the thermal perception of the interviewees.

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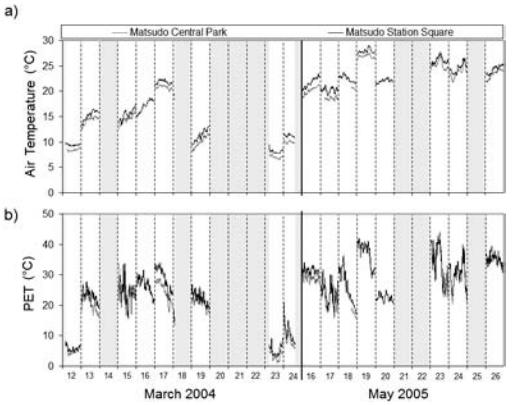
Figure 7
Ten-Minute Mean Values of (a) Air Temperature (T_a) and (b) Physiological Equivalent Temperature (PET) at the Human-Biometeorologically Significant Height of 1.1 m Above the Ground at Matsudo Station Square and Matsudo Central Park, Between 11 a.m. and 3 p.m. March 12–24, 2004 and May 16–26, 2005



Note: Rainy days and days when no measurements were performed are marked with gray. Note that data is missing in Matsudo Central Park March 16, 2004 and May 20, 2005.

Table 2
Physiological Equivalent Temperature (PET), Thermal Sensation, and Stages of Stress; Internal Heat Production: 80 W, Heat Transfer Resistance of Clothing: 0.9 (Matzarakis & Mayer, 1996)

PET (°C)	Thermal Sensation	Stage of Stress
4	Very cold	Extreme stress
8	Cold	Strong stress
13	Cool	Moderate stress
18	Slightly cool	Slightly stress
23	Comfortable	No stress
29	Slightly warm	Slightly stress
35	Warm	Moderate stress
41	Hot	Strong stress
	Very hot	Extreme stress

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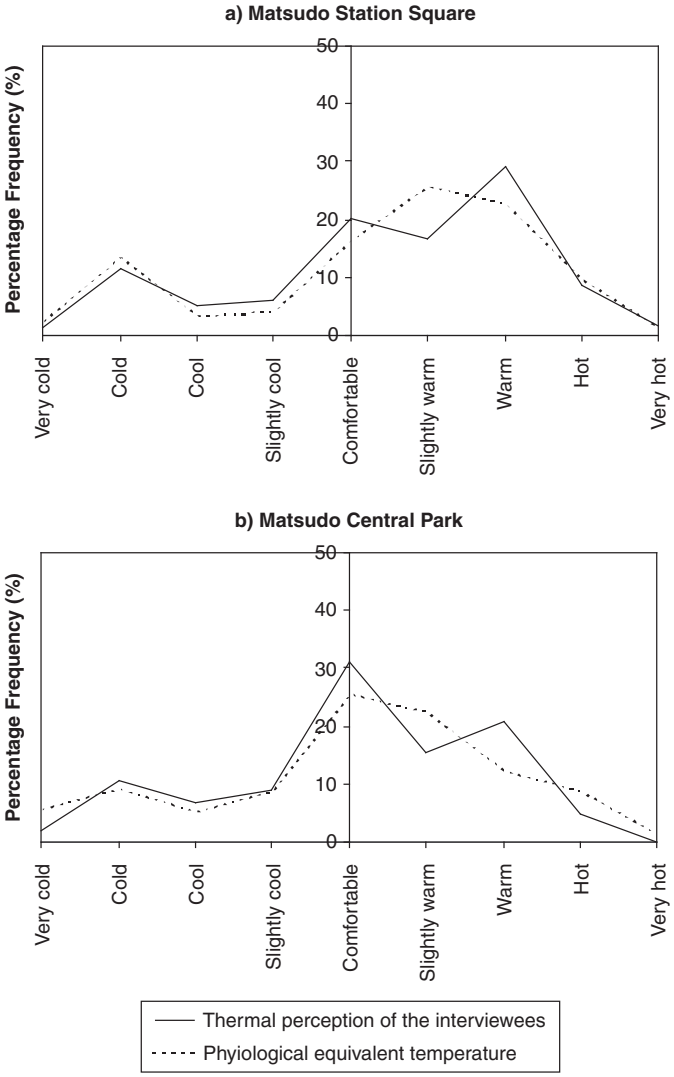
Figure 8
Percentage Frequency Distribution of Thermal Perception of the Interviewees and Calculated Physiological Equivalent Temperature (PET) at (a) Matsudo Station Square and (b) Matsudo Central Park



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Usage of Outdoor Places

The relation that people had to the places—whether they were living or working in the neighborhood, the most important reason for using the places, and the time spent in the places—were investigated using structured interviews. The results showed that 48.7% of the interviewees lived in the neighborhood, surrounding the park; 20.3% worked in the neighborhood; and 31.8% neither lived nor worked in the neighborhood. For the square, 36.7% of the interviewees lived in the neighborhood, 14.4% worked in the neighborhood, and 48.7% neither lived nor worked in the neighborhood.

Figure 9 shows the interviewees' primary reasons for using the two places. As shown, the majority of the interviewees (62%) in the park stated that it was to be outside to exercise, get some fresh air, relax, and so on. However, most of the people in the square (57%) reported being on their way home, or to or from work, school, shopping, and so forth.

Figure 10 shows the time spent in the park and in the square. As shown, most people spent 5 min or less in the two places. However, more people spent more than 10 min in the park (43.4%) than in the square (24.4%). The length of time each person remains in the places is largely influenced by the subjective perception of the thermal conditions, as shown in Figure 11. The more comfortable the perceived thermal comfort conditions, the more time people spent in the different places. When a person's perception of the thermal condition was within the acceptable comfort zone (slightly cool, comfortable, and slightly warm), then he or she spent an average of 19 min in the square and 21 min in the park. The time spent in the two places decreased considerably, to an average of 11 min when the person's perception of the thermal conditions fell outside of the acceptable comfort conditions (i.e., very cold, cold, cool, warm, hot, very hot).

The use and outdoor activity within the different places were obtained through unobtrusive observations of the naturally occurring behavior. In total, 337 observations were conducted and 7,304 individuals were recorded: 3,627 in the park and 3,677 in the square. Figure 12 shows the observed in situ activity within the two places. As shown, the park and the square are both important social places where a lot of people meet and socialize. Besides socializing, smoking and talking on mobile telephones were common activities in the square; these were not very common in the park. Instead, activities such as playing and exercising, eating and drinking, and walking the dog were more common in the park. It is noteworthy that sunbathing was a rare activity in both the park (0.2%) and in the square (0.6%).

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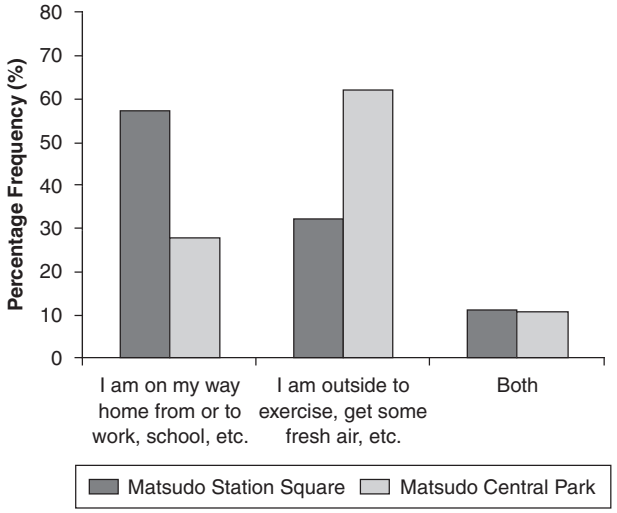
Figure 9
Percentage Frequency of People's Most Important Reason for Using Matsudo Station Square and Matsudo Central Park



The relation between the thermal environment—expressed as T_a—and PET and the total attendance in the two places is shown in Figures 13 and 14. The relation between the thermal conditions and the number of people in the square is found to be insignificant (Figures 13a and 14a). This indicates that the use of the square is independent of the thermal conditions. The use of the park, however, is found to be significantly and positively related ($p < 0.001$) to both T_a and PET, having attendance variances of 23% and 24%, respectively (Figures 13b and 14b).

Figure 15 shows the percentage of people seeking shade in the square and the park as a function of T_a. The number of people seeking shade is significant and positively related ($p < 0.001$) to T_a in both places. However, as shown in Figure 15a, only a small number of people (an average of 14.5%) in the square sought shade. In the park, however, there is a strong, positive relationship between the number of people seeking shade and T_a. The number of people seeking shade increases rapidly with T_a. At T_a higher than 20°C, an average of 80% of the visitors are seeking shade.

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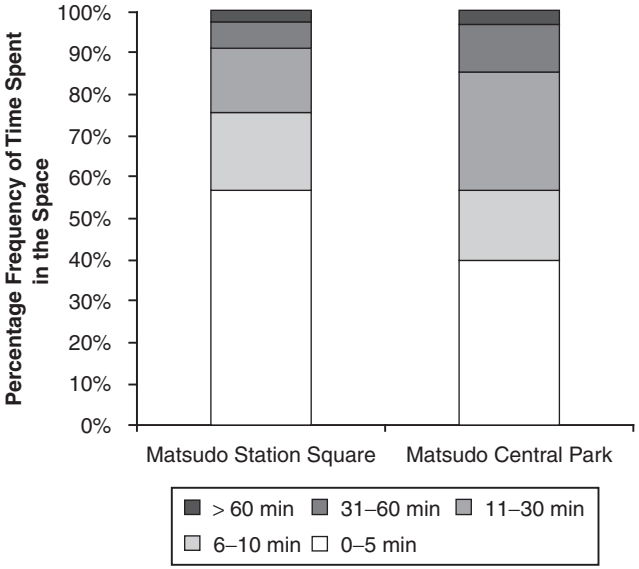
Figure 10
Percentage Frequency of Time Spent in Matsudo Station Square and Matsudo Central Park



Discussion

Spatial and Temporal Variations in the Thermal Environment—Implications for Subjective Perception and Satisfaction

The T_a was an average of 1.1°C lower in the park in comparison to the square, with a maximum difference of 3.0°C being recorded. There were even larger differences in the calculated PET. The differences in T_a and PET can be explained by the differences in the physical properties of the two urban places—in terms of geometry, orientation, and surface characteristics. In general, the square is both warmer and drier. The relatively higher PET values in the square indicate a heat load of greater intensity for humans in the square compared with the park, which is also reflected in the thermal perception of the interviewees (Figure 8).

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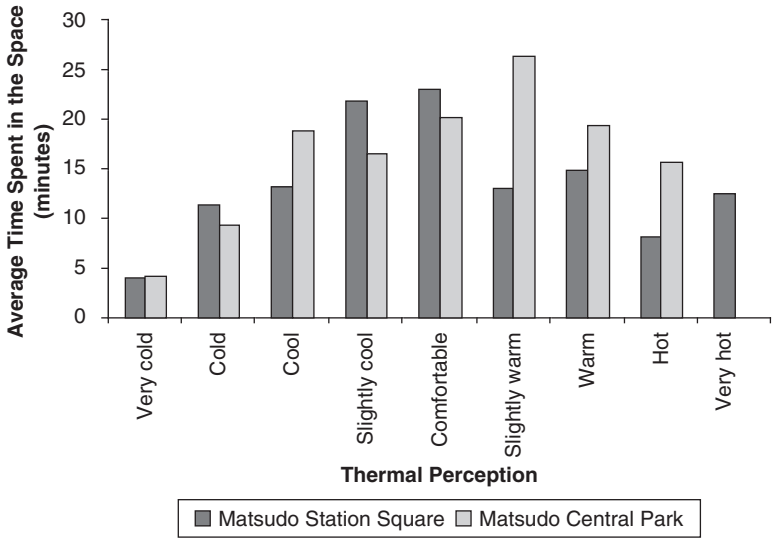
Figure 11
Average Time Spent in Minutes in Matsudo Station Square and Matsudo Central Park by Subjective Perception of the Thermal Environment



Thermal Environment—Use and Outdoor Activity

This study shows that the thermal environment (T_a and PET) has a greater influence on the use of the park, in terms of total attendance and behavior in relation to sun and shade pattern, than on the use of the square (Figures 13, 14, and 15). This can be explained by the different functions of the two places. The square is mostly used as a route place, where a lot of commuting people pass through during daytime on their way home or to or from work, school, and so on (Figure 9). As shown in Figure 10, most people in the square spend only a few minutes at the place—taking enough time to have a cigarette or to make a short telephone call (Figure 12). In this type of place, discomfort will be moderate as the time of exposure to the specific environment is limited. As a result, thermal conditions will have a rather low influence on the use. The park, on the other hand, is mostly used as a resting place, where most people visit to relax, exercise, eat lunch, and so on (Figures 9 and 12);

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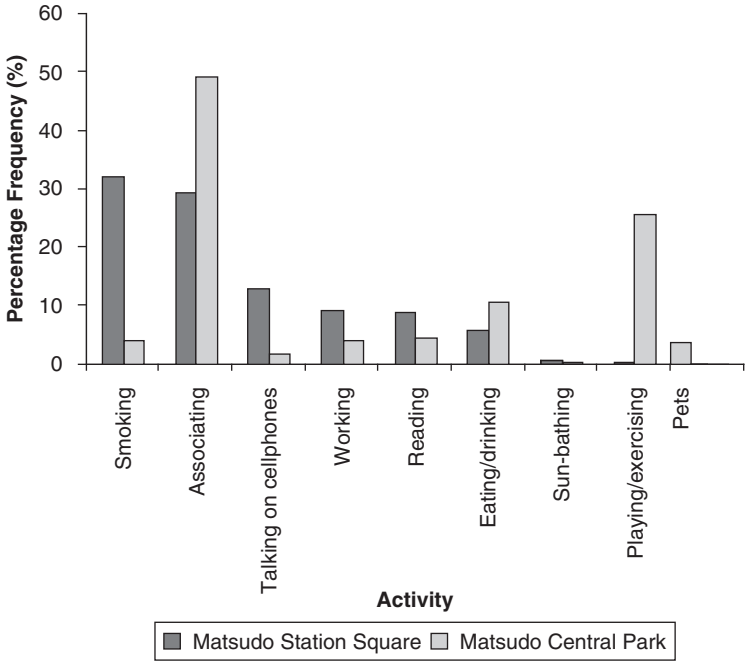
Figure 12
Percentage Frequency Distribution for Observed in situ Activity in Matsudo Station Square and Matsudo Central Park



these are activities that require the people to spend a longer time in the place (Figure 10). In this type of place, the situation is different, as poor thermal comfort conditions may stress people, leading them to avoid using the place (Figure 14), spend less time in it (Figure 11), or adjust their thermal conditions by moving in or out of the shade (Figure 15).

The fact that so few people seek shade in the square (see Figure 15a) can, to some extent, be explained by the limited amount of shade in the square, especially at noon. Another explanation is that many people in the square have just come out from a building or transportation and have a desire to charge-up the body in the sun. This is an explanation that was previously discussed by Nikolopoulou and Steemers (2003) and Thorsson (2003).

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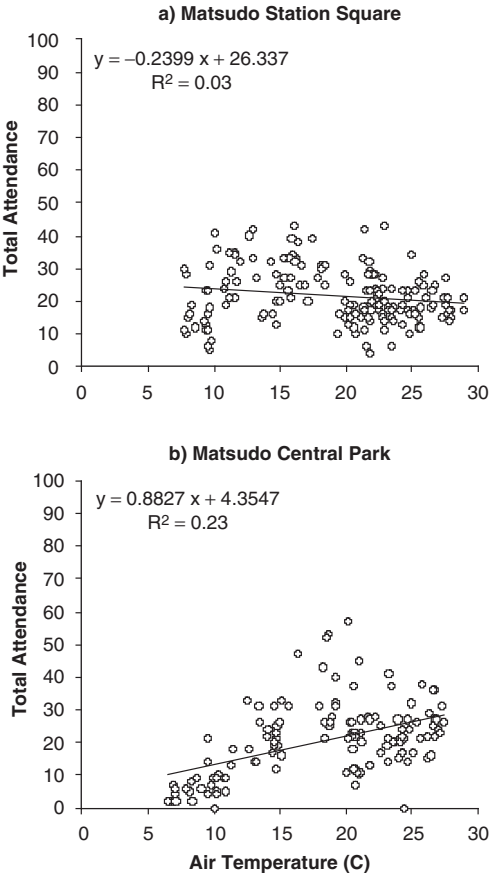
Figure 13
Total Attendance With Air Temperature at (a) Matsudo Station Square and (b) Matsudo Central Park



Attitudes Toward the Sun and Time Spent Outdoor—Climate and Cultural Differences

Compared to similar studies performed in Göteborg, Sweden (Eliasson et al., in press; Lindberg et al., in press; Thorsson et al., 2004)—which show a strong positive relation between the thermal environment and the extension

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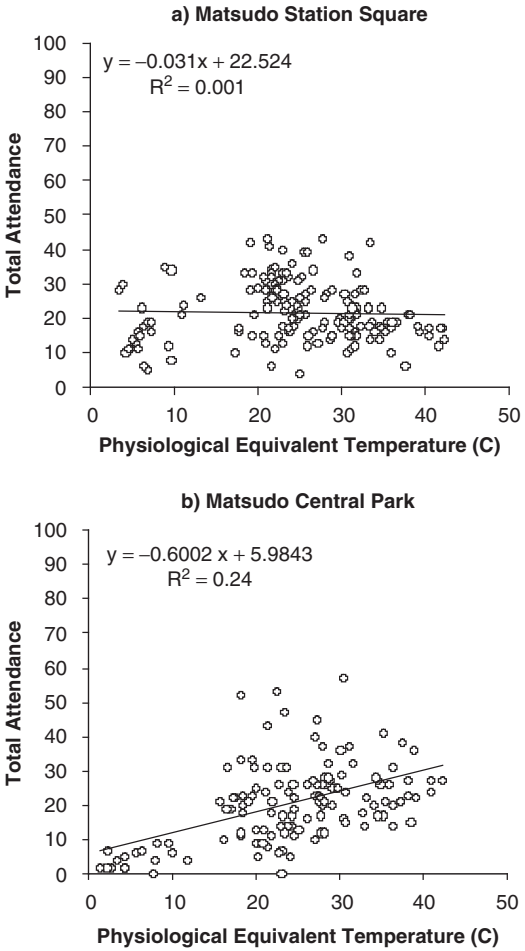
Figure 14
Total Attendance With Physiological Equivalent Temperature (PET) at (a) Matsudo Station Square and (b) Matsudo Central Park



and characteristics of activities in different urban places such as parks, squares, and waterfront plazas—this study shows a rather poor relation between the thermal environment and usage, in terms of total attendance. Apart from the

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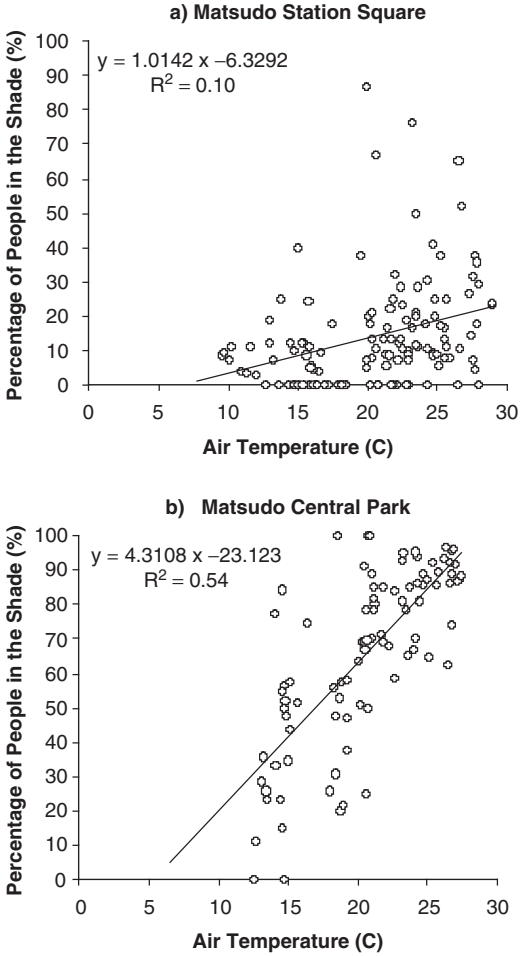
Figure 15
Percentage of People in the Shade With Air Temperature at (a) Matsudo Station Square and (b) Matsudo Central Park



differences in attitudes toward spending time outdoors, this study also shows differences between Sweden and Japan with respect to the attitudes toward the sun. As shown in Figure 15, 80% of the visitors in the Japanese park sought

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shade at temperatures higher than 20°C. This can be compared with a Swedish study, which showed that only 14% of the park visitors sought shade at temperatures higher than 20°C (Thorsson et al., 2004). Another difference in attitude toward the sun is shown in the number of people sunbathing. As shown in Figure 12, sunbathing is a rare activity, both in the Japanese park (0.2%) and in the Japanese square (0.6%). However in Sweden, sunbathing is a frequently occurring activity during sunny weather conditions (Thorsson et al., 2004). The differences between the countries with regards to the attitudes toward the sun and the time spent outdoors can be explained by climatic and cultural differences. It is well known that the dark winters and the subsequent short, lush summers in Scandinavia have created a special relationship between the inhabitants and the sun (Gehl, 1996). If it is possible to enjoy the sun only for a short period, the urge to do so is great. In Scandinavia, cold weather and short days limit the time spent outdoors during large portions of the year. In Tokyo, Japan, however, cold weather is seldom a problem. Apart from the differences in climate, there are differences in the perception of ideal beauty between the countries. For example, in recent decades, the Scandinavian ideal of beauty has included a suntan, whereas in Asia, the ideal of beauty is fair skin. The above examples can explain the fact that most people in northern Europe automatically choose a place in the sun, whereas Japanese people tend to avoid the sun to a greater extent.

Conclusions

The objective of this study was to examine the usage and levels of activity in two different Japanese urban places: a park and a square. Spatial and temporal variations in the thermal environment and its influence on usage and subjective perception were investigated. The study shows that differences in PET occur between the square and the adjacent park, resulting in different heat loads for humans between the places. In general, there is a poor relation between the thermal environment and the use of the two designated areas. However, the use of the park is more influenced by weather than by the use of the square, which can largely be attributed to the different functions of the places. The study also reveals differences between the attitudes toward the sun and the time spent outdoors in Japan and Sweden. Compared to Sweden, where thermal conditions have a strong influence on the use of outdoor urban places, this study shows that thermal conditions have a rather limited influence on the use of Japanese urban places. This can be attributed to climatic and cultural differences between the two countries.

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