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Thermal-environment experience of school children and their development of the associated cognition in summer

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ABSTRACT

It is important for occupants to be able to adjust their indoor climate appropriately, but for this, they need to be sensitive enough their immediate thermal environment. This paper describes the result of a series of physical measurement and subjective experiment focusing on thermal cognition of school children. In the measurement, they carried a small thermometer with data logger one by one while they stayed at school for three days from 8th to 10th September in 2008. In the experiment, they were requested first to imagine air temperature, relative humidity and six surface temperatures (ceiling, floor and four walls) in their classrooms and then to measure their actual values with thermometers and so on once a day. Through the above-mentioned measurement and experiment, we found the following with respect to thermal cognition of children: more than a half of children evaluated thermal environment of the classrooms comfortable, even if the air temperature reached 30℃. Almost all children imaged both air temperature and six surface temperatures lower than those measured.

Keywords

Children, Acquired Thermal Cognition, Thermal Environment Monitoring, Imagined Comfortable Temperature

INTRODUCTION

It is important for occupants to be able to adjust their indoor climate appropriately, but for this, they need to be sensitive enough their immediate thermal environment. Contemporary, heating and cooling systems that control the indoor climate almost automatically at any desired levels, occupants they be forced to believe that they do not need to take action for changing indoor climate. This may have caused them their chances to make adaptive control and thereby to lose their built-in physiological and psychological ability of controlling their thermal environment.

One's lifestyle in relation to thermal environment must grow in "the cyclic process from sensation to behaviour" [1]; that is, he/she senses changes in the thermal environment through his/her sensory portals, then perceives and recognizes by his/her brain, and then if an adjustment is recognized to be necessary, he/she takes actions by moving muscles. The ability of thermal sensation is already set up as he/she is born,

and it grows with various influential factors through his/her experience ever since then. We call it acquired thermal cognition [2]. According to previous researches regarding to thermal adjustment behaviour of occupants [3, 4], passive strategies such as cross ventilation, the use of small fans or air conditioning, and various behavioural patterns such as the choices of cooler paths approaching to the buildings and the change of clothes vary very much in the course of the continuous input of information from the thermal environment. The same is true for their associated thermal cognition. The whole process involves adaptation.

In this study, two surveys focusing on the thermal cognition of children were set up. The purpose of this investigation is to have a better understanding of what kind of thermal environment they experience in school, and how they recognize their thermal environment.

MEASUREMENT

The purpose of this measurement is to understand thermal environmental condition around the children and their thermal cognitions. The physical measurement was carried out in terms of the surrounding temperature and humidity of eighty-eight children around ten years old. They carried small thermometers with data logger one by one while they stayed at school for three days from 8^{th} to 10^{th} September in 2008. During the period of this measurement, the children also declared their thermal cognitions three times. Before and after this measurement, they also declared the comfortable temperature they imagined for summer.

EXPERIMENT

The purpose of this subjective experiment is to understand how the children perceive and recognize their thermal environment. They were requested first to answer the questions about thermal cognition. They were asked to imagine the values of thermal environment quantities: air temperature; relative humidity; and six surface temperatures (ceiling, floor and four walls) in their classrooms and record those values on the scales with blue ink provided on a sheet of paper. Lastly, they measure the actual values with thermometers and write down the values on the same scales with red ink. Through these steps, children could see themselves the difference between their imagined values and the measured values. This procedure was repeated for four times: the first and second were carried out on the same day right before the three-days physical measurement, the third was done after the physical measurement, and the fourth was done two weeks later from the third.

RESULTS AND DISCUSSION

Distribution of comfort votes

The thermal environmental conditions they experienced during the measurement and the distribution of their comfort votes are shown in Fig.1. The percentage of the comfort votes appeared in the respective ranges of air temperature and relative humidity are given. More than a half of the children evaluated their thermal

environment of the classrooms to be comfortable, even if the air temperature reached 30℃.

Classification by their thermal declaration

Although all of the children experienced physically the same thermal environment, there were some differences in their thermal cognition. The cognition seems to show its characteristics well dependent also on the difference between the imaged and measured thermo-physical quantities in the experiment. In this analysis, three types of their comfortable pattern are classified by its average and standard deviation of their votes. Type A has small standard deviation, and their most declarations were “hot” or “slightly hot”. This means the children of Type A tend to feel hotter than others. The most declarations of Type B are “neutral” on the other hand. This means Type B tend to be sensitive to their thermal environment, since their declarations stayed almost the same. The declarations made by the children of Type C scattered. This means that the standard deviation of their votes were large. Type C may have been able to feel and distinguish thermal environment around them finely.

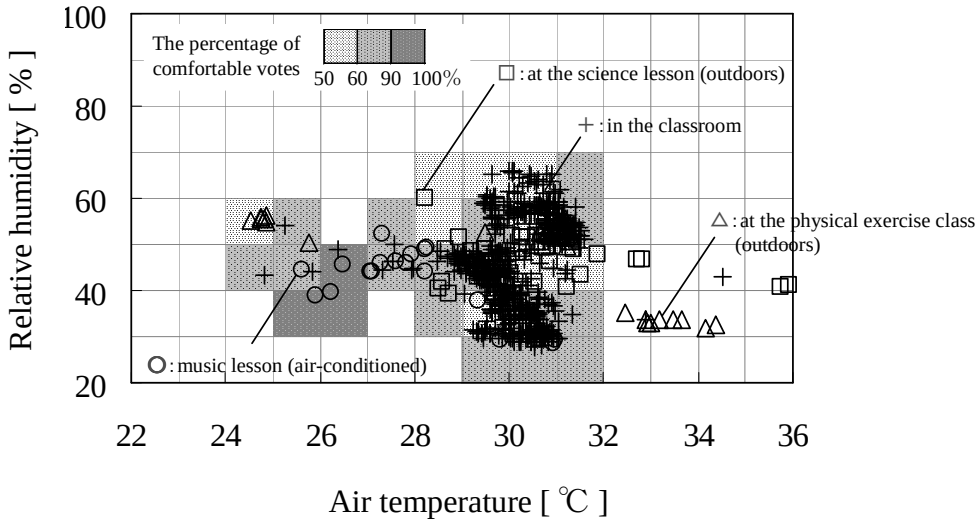

Fig.1 Distribution of the comfort votes and their thermal environmental conditions

Imagined values

Fig.2 shows that the differences in physical quantities between imagined and measured. Through the four times of the respective experiment sessions, the differences between two values got closer by little and little in the cases of air temperature and radiant temperature. Almost all children imaged both air temperature and six surface temperatures lower than those measured. This tendency seems to us that there is a possibility to create comfortable thermal environment for them with a higher air temperature value than the air temperature they believed comfortable. Since there was no tendency found through four experiment sessions in the case of relative humidity, it seems harder to imagine the value of relative humidity than air temperature and radiant temperature.

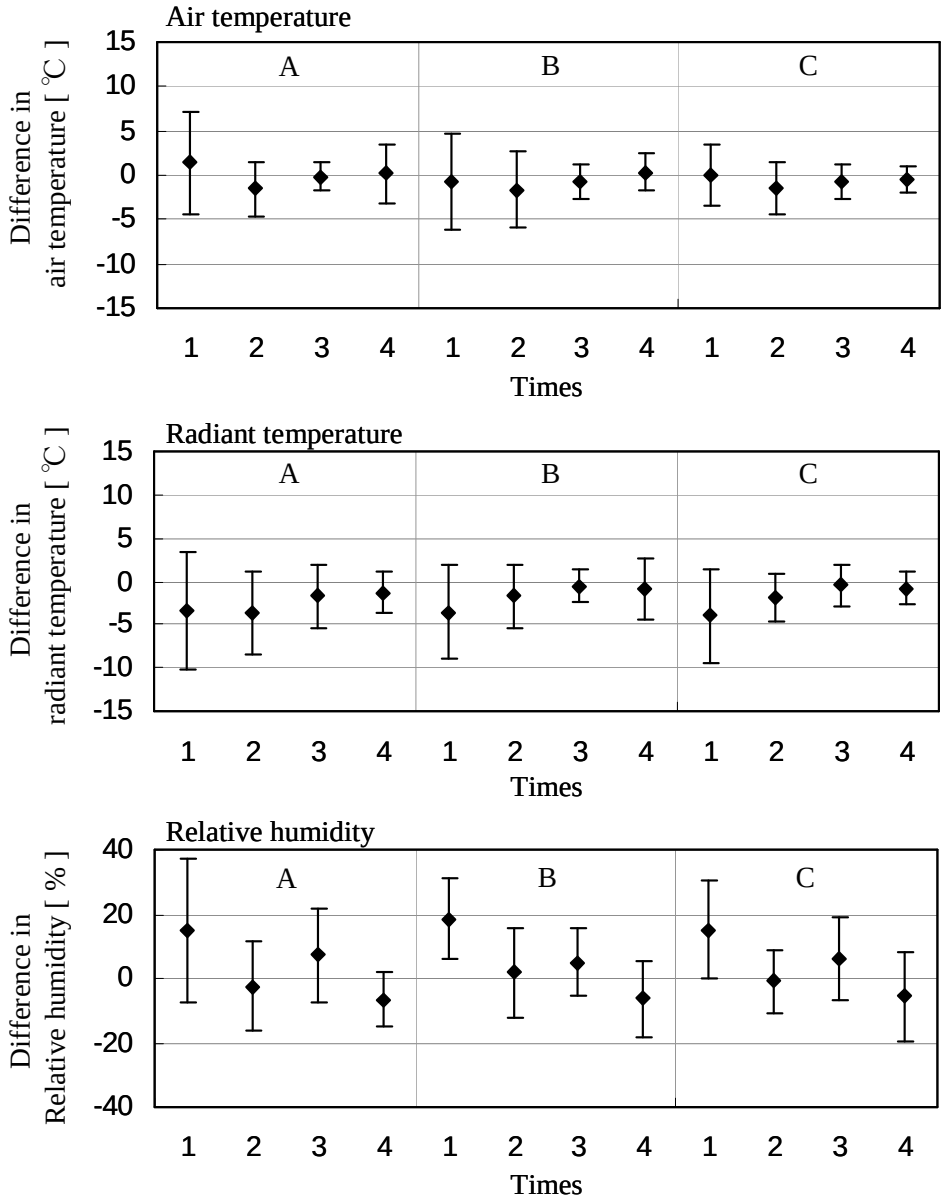

Fig.2 The difference between imagined and measured

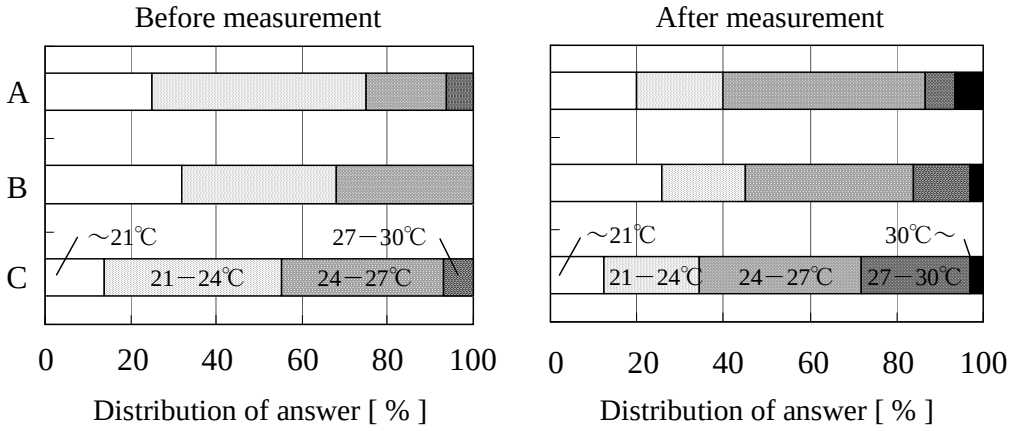

Fig.3 Comfortable temperature imagined

Comfortable Temperature Imagined

Before and after these series of measurement and experiment, the children were asked to choose the surrounding temperature, possibly a combined temperature value of the room air, the surrounding surfaces, and the equivalent temperature rise due to solar radiation temperature that they imagine comfortable. The comfortable temperature value that they imagined after the measurement and the experiment turned out to be higher and nearer than those before the measurement and experiment. This suggests that they must have developed their own thermal cognition through this series of measurement and experiment.

CONCLUSION

This paper described the result of a series of physical measurement and subjective experiment focusing on thermal cognition of school children. More than a half of children evaluated thermal environment of the classrooms comfortable, even if the air temperature reached 30℃. Almost all children imagined both air temperature and six surface temperatures lower than those measured. Through this series of measurement and experiment, we found that their thermal cognition could be developed through some experiment perception of temperature and the measurement of temperature.

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