別紙４－１（課程博士（英文））

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Abstract（Doctor）

Title of Thesis	Assessing thermal responses of Indonesian and Japanese students in summer and winter

Approx. 800 words

Thermal comfort is crucial in satisfaction and maintaining quality sleep and next-day performance for occupants. This study investigated the comfort temperature in the bedroom at night, sleep quality, and next-day performance (brain response) for Indonesian and Japanese students during summer and winter. The main objective of this study is to investigate the effect of thermal comfort on sleep quality and next-day brain response in Indonesian living in Japan and Japanese. This main objective is further divided into some sub-objectives, i.e., (1) to investigate the sleep quality and next-day brain response of Indonesian and Japanese groups in the summer season, (2) to investigate the sleep quality and next-day brain response of Indonesian and Japanese group in the winter season, (3) to analyze the effect of thermal comfort on sleep quality of Indonesian and Japanese group, (4) to analyze the effect of thermal comfort on brain response of Indonesian and Japanese group, and (5) to analyze the effect of sleep quality on next-day brain response.

In the summer and winter study, the comfort temperature, sleep quality, and subsequent performance of Indonesian and Japanese students were compared. During sleep, actigraphy was used to evaluate sleep quality. Prior to sleep, all participants completed a survey regarding thermal sensation, physical condition, and subjective sleep sensations. Additionally, the temperature and relative humidity of the participants' bedrooms were recorded. After waking up, the participants completed the sleep sensation questionnaire and continued to the next-day performance experiment. In the next day performance, the brain response (event-related potentials with a late positive component and latency ~300 milliseconds; hereafter referred to as "P300" in the present study) and reaction time of Indonesian students, as tropical natives living in Japan, and Japanese students were investigated and compared in natural (hot during summer and cold during winter) and comfort conditions (with cooling and heating).

The average bedroom temperature and relative humidity of Indonesian and Japanese groups were comparable during the summer. Moreover, Indonesian group had a higher comfort temperature than Japanese group and previous studies conducted in Japan. The Griffiths method indicated that the summer's means of comfort temperature for Indonesian and Japanese were 28.1 °C and 26.1 °C. Indonesian students' bedtime (duration on bed) and sleep minute were comparable to

those of Japanese students during the summer. However, the sleep rate of Indonesian students was lower than that of Japanese students. In the next-day brain response experiment, the current study showed that there were no differences in P300 potential and latency of participants (Indonesian and Japanese groups) between cooling and hot conditions. Moreover, after performing Uchida Kraepelin (U-K) test during comfort conditions (cooling during summer), the reaction time (RT) and the number of lapse (RT > 500ms) of Indonesian group showed delayed and increased significantly, respectively.

This study also indicated that the bedroom temperature of Indonesian students was significantly warmer than Japanese students during winter. In winter, majority of Indonesian students prefer "warm" in contrast to the preference of Japanese who mostly prefer "neutral." According to the thermal comfort survey, Indonesian had a lower value than Japanese in winter. Moreover, there was a significant difference in the wake-up time of Japanese students in the sleep quality study. Actigraphy measurements indicated that the Indonesian participants' waking time coincided with sunrise. Japanese participants, on the other hand, awoke later than Indonesian students. In the comfort temperature, the Griffiths method indicated that the winter means of comfort temperature for Indonesian and Japanese were 23.5 °C and 16.0 °C. In the next-day brain response experiment, there were no differences in P300 potential, P300 latency, and RT of Indonesian and Japanese groups between cold and heating conditions in the winter. Moreover, after performing the U–K test at heating condition, the RT of Indonesian group showed a significant delay.

Principal component analysis showed the following results: eight variables of thermal sensation questionnaire in sleep survey can be simplified with two factors (TS1 and TS2, 59 % of cumulative variability), seven variables of sleep sensation questionnaire in sleep survey can be simplified with two factors (SS1 and SS2, 72 %), and seven variables of thermal sensation questionnaire in brain response experiment can be simplified with two factors (TE1 and TE2, 77%). In the sleep quality of Indonesian group, TS1 was correlated with sleep rate and sleep latency. In Japanese group, TS2 was correlated with sleep rate, sleep efficiency, and SS1. In brain response of Indonesian group, TE2 was correlated P300 latency. In Japanese group, TE1 was correlated with P300 potential and TE2 was correlated with P300 potential and latency. In the correlation analysis between sleep quality sensation and next-day brain response, the duration on bed, sleep minute, and sleep rate were correlated with P300 latency. In the sleep sensation, SS1 was correlated with P300 latency, sleep vote, endurance, and speed of U-K test, SS2 was correlated with P300 potential, consistency, accuracy, and correct rate of U-K test.

The methodology might be replicated in the future study, which is evidently useful to investigate sleep quality and next-day brain response in the natural and comfortable environment setting. This research contributes a piece of new knowledge regarding sleep quality, thermal comfort, next-day brain response, particularly for tropical natives living or working in Japan.