Effects of Air Temperature Step Changes on Physiological Responses and Mental Task Performance in Indonesian and Japanese Subjects

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（気温のステップ変化がインドネシア人及び日本人被験者における生理反応及び精神作業パフォーマンスに与える影響）

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Abstract of Dissertation

Office workers frequently experience up-step and down-step air temperature when moving out of and into a relatively cold office building in tropical and temperate countries in the summer. Air temperature step changes promptly suppress or activate thermoregulation functions. While the effects of air temperature step changes on thermoregulation, cardio circulatory, brain function, and mental task performance in different heat acclimatization level were unknown. Therefore, the purpose of this study was to provide basic knowledge regarding the effects of air temperature step changes to support human health and work performance in tropical and temperate subjects. The main objectives were: (1) to investigate temperature step changes phenomenon in the actual office environment, (2) to investigate the effects of air temperature step changes and heat acclimatization level (Indonesian and Japanese) on physiological responses and calculation task performance.

To achieve objective (1), thermal environments, thermal perceptions and perceived arousal in the actual environment were measured. To achieve objective (2), a laboratory study investigating thermoregulation function, circulatory function, thermal perception, and calculation task performance in Japanese and Indonesian subjects was conducted under air temperature step changes of 22-32-22 °C (C10) and 28-32-28 °C (C4). Additionally, an extended study was performed with additional measurements of cardio circulatory and brain functions.

Results of each experiment were: First, air temperature step changes of 23-32-23 °C significantly increased thermal sensation, significantly decreased thermal comfort and perceived arousal after the down-step temperature in Indonesian workers in their actual working site compared to the air temperature step changes of 24-29-24 °C. Second, air temperature step changes of 22-32-22 °C resulted in the significantly higher correct answer rate of calculation task ($p < 0.05$) at the end of heat exposure in Japanese subject than the air temperature step changes of 28-32-28 °C. After down-step

temperature, their performance decreased due to the stronger vasoconstriction induced thermal discomfort, resulted in the lower changes of performance ($p = 0.051$) than the Indonesian subjects. Third, air temperature step changes of 22-32-22 °C was more beneficial in reducing heat strain after up-step and down-step temperature in Japanese subjects, than in 28-32-28 °C. It suppressed the rise of sympathetic activity during up-step, prevented cerebral oxygenation decrement during down-step, and also increased arousal level ($p < 0.05$) after the down-step temperature in Japanese subjects, compared to the Indonesian subjects. Thus, air temperature step changes of 22-32-22 °C resulted in tendency of the better calculation performance ($p < 0.1$) under heat stress in Japanese than in Indonesian subjects.

The finding provides novelty that thermal acclimatization status in the previous phase affected the physiological responses during calculation task in the next phase. These responses were more sensitive to the larger gap of air temperature step.