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OFFSET OF WARM SENSATION BY LOCAL AIR FLOW: CHINESE AND DANISH PREFERENCE

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INTRODUCTION

In the recent years, evidences support that elevating air speeds may also be perceived as pleasant in particular in warm/hot and humid environments, which could also result in better perceived air quality (PAQ) (Melikov and Kaczmarczyk 2012, Zhai et al 2013) and lower energy consumption (Schiavon and Melikov 2008, Zhang et al. 2010). The potential of using higher air velocities, to provide room occupants' thermal comfort at elevated room temperatures, has been recognized in ASHRAE 55 (2010).

Many of the on-field available studies, concerning the acceptable use of higher air movement, have been conducted in warm/hot climate regions (Cândido et al 2011). While the acceptability of the cooling effects from the increased air movement, on occupants accustomed to cold or temperate climate, are not well defined. To have a direct comparison on the cooling effects of local air flows impacting the front upper body part, between cold climate adapted people (e.g. Danes) and warmer (e.g. people from Beijing in China), two similar experimental studies were selected and compared. In particular, an experimental study in a climate chamber office-like at the technical University of Denmark (DTU) was performed with 27 Danish participants. Warm room conditions and set ups were selected on references of Huang et al (2013) and Hua et al (2012) Chinese studies. Results of occupants' acceptances of air velocities and of airflow patterns´ preferences from those similar studies were here compared and discussed.

METHODOLOGIES

The similar observed human subjects' studies included two experimental parts. In the first section the subjects were exposed to constant air flows provided by desk fans at warm room temperatures of 26~34 ˚C with absolute humidity constant at 12.2 g/kg for Danish people (Simone et al, 2014), and at warm room temperature of 28 ~34 ˚C with relative humidity in

the range of 40-50% in Huang's study (2013) having Chinese occupants. While the second part, the subjects were exposed to constant air flow and simulated natural wind air movement, having the mean preferred air speed chosen during the first exposure at 28℃ and 30 ˚C of room temperature for Danish people, and 1.0m/s in Hua's study (2012) for the Chinese people. The subjects experiment, conducted first in China and later in Denmark, used the same desk fans developed at Tsinghua University in China, which could generate different types of air flow patterns with high air velocity, as explained by Hua et al. (2012).

The human subjects experiment with Danish population was conducted in an experimental climate chamber office-like at the International Centre for Indoor Environment and Energy (ICIEE) at DTU. More details about the room experimental set up, instruments, and participants can be found in Simone et al (2014). The second human subjects´ experiment with Danish people was performed with room temperatures at 28 ˚C and 30 ˚C, and absolute humidity constant at 12.2 g/kg. The participants were exposed to the warm environmental conditions for 2 hours having 1h exposure to local constant air flow and 1h to the natural simulated wind air flow (dynamic air flow). The average air speeds of the two air flow patterns were 0.8m/s at 28 ˚C and 1.0m/s at 30 ˚C (chosen to be equal to the subject preference expressed during the first experimental exposure). The two types of air flows were randomly provided by the desk fans. During the exposure, the subjects were required to do task performance, such as Tsai and Typing, keeping the activity level equal to 1.2 met. In the end of the exposure to each type of air flow, they were asked to fill-in questionnaires (Q) feeling about returning the occupants´ assessment about air movement and thermal sensation perceptions, thermal comfort and subjective symptoms.

RESULTS AND DISCUSSION

Danish population were less adapted to air velocity above 1.0 m/s than Chinese. When the local air flow were provided under personal controls, the comfortable indoor air temperature could be extended to 31.7 ºC for the Chinese and 29.7 ºC for the Danes. The dynamic air flow was found satisfying more than the constant air flow for the Chinese' group as their thermal sensation improved. But no significant difference of TSV ($P>0.05$) due to the two types of air flows on the Danish subjects was found as well as their thermal comfort assessments according to the Independent Samples Test. However, the Danish subjects accepted the constant air movement as better cooling support, and were less satisfied with the dynamic air flow.

The differing demands of air movement in air velocity and airflow pattern between the Chinese and Danish population, might be contributed to their different behaviour actions adopted by the two population as consequence of their different thermal experiences. The Chinese subjects of Beijing live in the city, in which the outdoor temperature can easily reach higher than 32℃ and the fans were widely used to keep comfort in summer time. So the Chinese are not subject to temperature excursion. However, the Danish subjects are normally exposed to cold outside temperatures that barely reach 30˚C in summer time, resulted in that

they are more and more used to a very tight buildings making them to perceive as no good the strong and variable air movement which sometimes reaches very high air velocities.

CONCLUSIONS

Danish population were less adapted and, as consequence, less likely to air velocity above 1.0 m/s than Chinese. With the local cooling effect of the airflows under personal control, the indoor comfortable air temperature could be extended to 31.7˚C for the Chine se and to 29.7 ˚C for the Danes. In additions, the Chinese preferred more dynamic air flow, while the Danes accepted more to the constant air flow. Findings indicated that people, used to different climate regions, present different demand on air movements regard air velocity and airflow patterns. More tests and results should be performed and compared with people from others climatic regions.

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