

DISSATISFACTION AMONG TROPICALLY-ACCLIMATIZED SUBJECTS WITH VENTILATOIN APPLIED TO THE FACIAL REGION

K. W. Tham ^{1†}, and N. Gong ²

¹*Department of Building, National University of Singapore, Singapore*

²*Parsons Brinckerhoff Pte Ltd, Singapore*

ABSTRACT

Personalized Ventilation (PV) has been shown to improve inhaled air quality recently. However, it may lead to dissatisfaction such as draft due to personalized air applied locally to the facial region, or stuffiness due to inadequate air supply. This study aims to identify some reasons for the dissatisfaction among tropically acclimatized people through a systematically experimental design.

In this study 24 subjects were subjected to a series of random facial exposure to local air movement each of 15 minutes duration in a well-controlled indoor air quality chamber. The exposures comprise various combinations of PV supply temperatures (21 to 26 °C), ambient temperatures (23.5 and 26 °C) and PV air supply velocities (0.15 to 0.9 m/s).

The study shows that among those who are dissatisfied and preferred less air movement, about 85% attributed their dissatisfaction to draft or perception of too much air movement. Drying effects contributed only secondarily to the dissatisfaction (less than 10%).

Among those who are dissatisfied and preferred more air movement, more than 70% attributed the dissatisfaction to insufficient cooling or perception of too little air movement. Air quality accounted for less than 5% of the dissatisfaction. However, the reasons for dissatisfaction of a significant portion (about 20%) remain unidentified.

KEYWORDS

Dissatisfaction, Reasons for dissatisfaction, Local air movement, Personalized Ventilation, Tropically-acclimatized

INTRODUCTION

Personalized Ventilation (PV) has been shown to improve inhaled air quality (Fanger, 2001; Melikov et al., 2002; Sekhar et al., 2005). However, it may lead to dissatisfaction such as draft due to personalized air applied locally to the facial region, or stuffiness due to inadequate air supply. While dissatisfaction with local air movement applied in the facial region of tropically-acclimatized people has recently been reported (Zhou et al, 2005; Gong et al 2006; Sun et al 2006), the reasons for the dissatisfaction has not been systematically studied.

Various factors may cause dissatisfaction of local air movement in the facial region. It is well known that within comfort temperature range (usually room temperature from 22.5 to 26 °C), draft can be a common reason of dissatisfaction (McIntyre, 1980; Fanger and Christensen, 1986). Meanwhile, dissatisfaction of air quality may lead to dissatisfaction with the air movement. Previous studies also

[†] Corresponding Author: Tel: + 65 6516 3539 , Fax: + 65 6775 5502

E-mail address: bdgtkw@nus.edu.sg

indicated that at higher velocities drying effects may cause dry eyes (Xia et al, 2000). According to McIntyre (1980), the physical effects are hardly evident below about 0.5m/s; above 1 m/s, however, the strength of the air movement begins to rise rapidly and may become a nuisance.

Therefore, plausible reasons of dissatisfaction are examined vis-a-vis thermal discomfort, air quality problem and local physiological discomfort such as dry eyes/mouth/nose to identify possible reasons of air movement dissatisfaction.

METHOD

In this study 24 subjects, divided into groups of 6, were subjected to a series of random facial exposures to local air movement, each of 15 minutes duration, in a well-controlled indoor air quality chamber. The local air movement was achieved by supplying conditioned outdoor air directly to the subjects' facial regions through air terminal devices, while the ambient temperature in the chamber was maintained by a separate air-conditioning system. The exposures comprise various combinations of PV supply temperatures (21 and 23.5 °C), ambient temperatures (23.5 and 26 °C) and PV air supply velocities (0.15 to 0.9 m/s) controlled at 15cm from subjects' facial region. At the end of each exposure, they were asked to indicate their level of satisfaction with the personalized ventilation, whether they preferred more or less ventilation, and the reasons for their dissatisfaction. The experimental conditions are depicted in Table 1.

Table 1 Experimental conditions

Room Temperature (°C)	26			23.5	
Local Air Temperature (°C)	21	23.5	26	21	23.5
Velocity (m/s)	0.15, 0.3, 0.45, 0.6, 0.75, 0.9				

The reasons for the dissatisfaction are explored within the responses to the questionnaire, which includes response to 'thermal sensation', 'air movement perception', 'inhaled air quality', 'freshness of inhaled air' and 'feeling of the environment (questions of eyes/nose/mouth dry)'. Subjective response of 'thermal comfort' is not considered since 'thermal comfort' may be a comprehensive perception and influenced by thermal sensation and air movement acceptability over the entire body.

The subjects may prefer less air movement or more air movement when they are dissatisfied with the local air movement; therefore, the reasons were identified respectively for the two scenarios, i.e., those of preference for less air movement and those for more air movement.

The preference for less air movement may be due to whole-body thermal sensation being in the cool state, i.e., whole-body thermal sensation equal or lower than -1 (slightly cool, cool or cold). The preference could be also due to the air movement on facial part perceived to be breezy (slightly breezy, too breezy, much too breezy). Local physiological discomfort, such as nose/lips/eyes dry, may lead the subjects to prefer to less air movement.

The preference for more air movement may be due to whole-body thermal sensation being in the warm state, i.e., whole-body thermal sensation equal or higher than +1 (slightly warm, warm or hot). The preference could also be due to the air movement on facial part perceived to be still (slightly still, too still, much too still). Subjects dissatisfied with inhaled air quality may prefer more air movement. Hence, a response of inhaled air quality that falls in the range of "just unacceptable" to "very unacceptable" is considered as a reason. Subjects may also perceive inhaled air to be stuffy and prefer more air movement. Therefore, stuffiness of local air could be another reason for the preference for more air movement.

RESULT AND DISCUSSION

Figure 1 shows the percentage of satisfied and dissatisfied, the preference for less/more air movement, and the reason for dissatisfaction. The percentage of satisfied and dissatisfied is calculated over all the number of subjects, the preference for less/more air movement calculated from the number of dissatisfied subjects, while the percentages associated with the various reasons for dissatisfaction are based on the corresponding number of subjects who are dissatisfied and preferring either less or more air movement.

Observed from Figure 1, a large portion (77.9%) of the subjects is satisfied with the air movement when all conditions are considered. The dissatisfied subjects are sub-divided into those preferring more air movement (61%) and preferring less air movement (39%).

Thermal sensation accounts for most preference for less air movement when subjects felt cool to cold (75.8%) and for more air movement (53.6%) when subjects felt warm. Air movement perception is the second major reason which accounts for the preference for less air movement (19.4%) and for more air movement (23.7%). The other reasons are usually trivial. Local physiological discomfort accounts for only a small portion of the preference for less air movement. Air quality related reasons (inhaled air quality and freshness of air movement) accounts for only a very small portion of the preference for more air movement. However, it is noticed that a high percentage (21.6%) of preference for more air movement is unexplained.

For the preference for less air movement or so-called "draft" (which is "draught" in Fanger et al, 1988 defined as "an unwanted local cooling of the human body caused by air movement"), the majority dissatisfaction with air movement preference (about 95%) can be attributed to thermal sensation and air movement perception, while other reasons of air quality, freshness of air and eyes/nose/mouth dry are only secondary (4.8%).

The "draft" may happen when either whole-body thermal sensation in the cool side (thermal sensation < 0), or when localized cooling is excessive arising from local air movement being concentrated at the facial region even when whole-body thermal sensation is warm (thermal sensation > 0). The localized (facial) cooling and ambient temperature will affect subjects' whole-body thermal sensation simultaneously.

The study showed that 75.8% of subjects' rating of preferred less air movement (Refer to Figure 1 of the portion with "thermal sensation < 0 ") happens when whole-body thermal sensation is in the cool side (thermal sensation < 0). When whole-body thermal sensation is in the cool side (and with facial thermal sensation normally in cool side or neutral state due to the cooler PV supply air or enhanced convective heat loss even at the isothermal supply state), even air movement perceived as low ("slightly still") and air velocity of 0.15 m/s could cause dissatisfaction leading to a preference for less air movement.

The study showed that 19.4% of subjects preferred less air movement (Refer to Figure 1 of the portion with "air movement perception > 0 ") when whole-body thermal sensation is in the neutral or warm side (thermal sensation $> = 0$). When whole-body thermal sensation is neutral or warm and with facial thermal sensation being "slightly cool" or "cool", air movement perceived as "slightly breezy" or "breezy" and air velocity above 0.3 m/s have caused dissatisfaction, resulting in a preference for less air movement. The findings suggest that draft perception is influenced by whole-body thermal sensation, which supports the previous finding of Toftum and Nielsen (1996).

For the preference for more air movement, most dissatisfaction of air movement preference (77.3%) can be explicated by thermal sensation and air movement perception. However, the reason of a

dissatisfaction portion about 21% is still unknown.

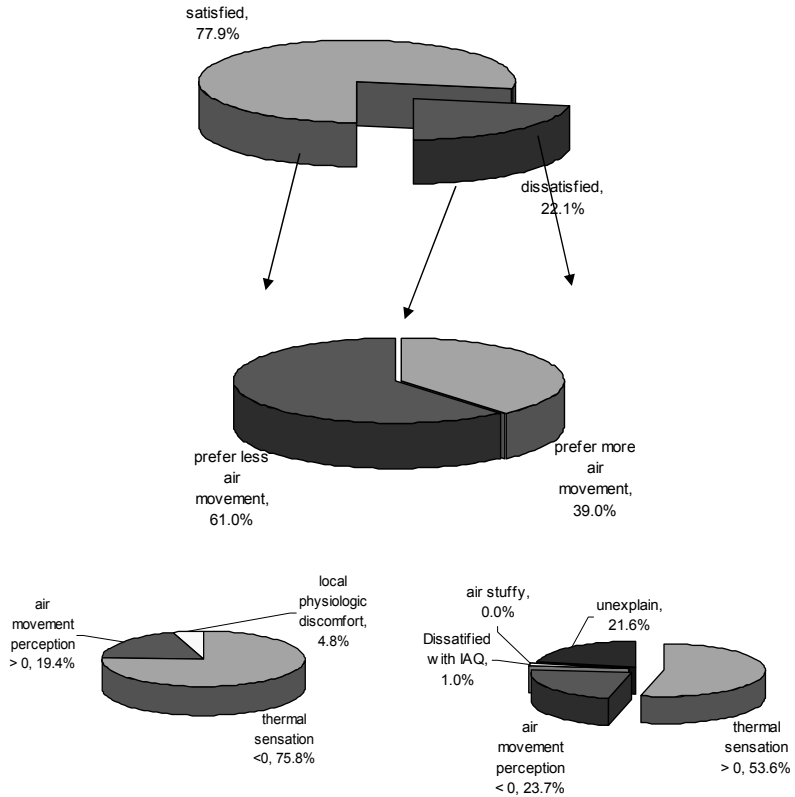


Figure 1 Reasons of dissatisfied due to local air movement

CONCLUSIONS

The study shows that the dissatisfaction with air movement is complex, which can be thermal, air quality, drying effects or air pressure related discomfort.

Among those who are dissatisfied and preferred less air movement, about 95% attributed their dissatisfaction to draft or perception of too much air movement. Drying effects such as those on eyes, nose and mouth contributed only secondarily to the dissatisfaction (less than 5%).

Among those who are dissatisfied and preferred more air movement, more than 77% attributed the dissatisfaction to insufficient cooling or perception of too little air movement. Air quality was not a

concern as it only accounted for 1% of the dissatisfaction. However, the reasons for dissatisfaction of a significant portion (about 21.6%) remain unidentified.

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