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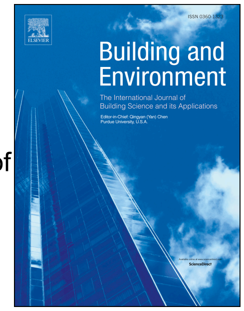

Ten questions concerning thermal and indoor air quality effects on the performance of office work and schoolwork

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Ten questions concerning thermal and indoor air quality effects on the performance of office work and schoolwork

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Abstract
Energy conservation in buildings as a way to reduce the emission of greenhouse gases is forcing an urgent re-examination of how closely thermal and air quality conditions should be controlled in buildings. Allowing conditions to drift outside the optimum range would conserve very large amounts of energy and would in most cases have only marginal effects on health or subjective comfort. The question that then arises is whether occupant performance would be negatively affected and if so, by how much. This information is required for cost-benefit analyses. The answers in this paper are based on laboratory and field experiments that have been carried out since the massive increase in energy costs that took place in the 1970s. Although only a few of the mechanisms by which indoor environmental effects occur have been identified, it is already clear that any economies achieved by energy conservation will be greatly exceeded by the costs incurred due to decreased performance. Reducing emissions by allowing indoor environmental conditions to deteriorate would thus be so expensive that it would justify greatly increased investment in more efficient use of energy in buildings in which conditions are not allowed to deteriorate. Labour costs in buildings exceed energy costs by two orders of magnitude, and as even the thermal and air quality conditions that the majority of building occupants currently accept can be shown to reduce performance by 5-10% for adults and by 15-30% for children, we cannot afford to allow them to deteriorate still further.

1) Do thermal conditions affect office work?

It seems that the thermal state of the body, however achieved, is what affects arousal and thus performance: no difference in the performance of a whole battery of different tasks was found between two conditions of thermal neutrality with very different clothing insulation and air temperature: 0.6 clo at 23°C and 1.15 Clo at 19°C (Wyon et al. 1975). In other words, thin clothing and warm air is equivalent to warm clothing and cool air, in terms of the resulting effect on both performance and thermal comfort.

Under moderately warm conditions, above neutrality, it is possible to avoid sweating by reducing metabolic heat production. This leads to a lowering of arousal, as people relax and generally try less hard to work fast. This is often a completely unconscious response to warmth. Aspects of mental performance with a low optimal level of arousal, such as memory (Wyon et al. 1979) and creative thinking (Wyon 1996a), are improved by exposure to a few degrees above thermal neutrality, but they too are impaired at higher temperatures, closer to and above the sweating threshold.

Tham and Willem (2010) showed that increased accuracy in the Tsai-Partington test indicates raised arousal, which improves concentration and would thus be expected to benefit rule-based logical thinking. They exposed heat acclimatised subjects living in the Tropics to 20, 23 and 26°C and observed higher arousal at 20°C, as indicated by measurements of stress biomarkers in saliva. Activation of the sympathetic nervous system and higher alertness are beneficial for tasks that require attention and the ability to sustain prolonged mental effort.

Individual control of the thermal environment may be necessary if optimal performance of office work is to be achieved. Wyon (1996b) showed that individual control equivalent to ±3°K would be expected to improve the performance of mental tasks requiring concentration by 2.7%. A decrease of this magnitude (2.8%) in the rate of claims-processing in an insurance office had been demonstrated by Kroner et al. (1992) when individual microclimate control devices in an insurance office