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Do people like to feel 'neutral'? Exploring the variation of the desired thermal sensation on the ASHRAE scale

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Abstract

This analysis explores the pattern of variation of the desired thermal sensation on the ASHRAE scale, applying the method of direct enquiry. Data are from studies of thermal comfort at university lectures and in selected dwellings. Respondents reported both their thermal sensation and the sensation they would have desired at that time. The data contain 868 comparisons of the actual and the desired sensation. On 57% of occasions the desired sensation was other than 'neutral'. The respondents did not always desire the same sensation, and the mean desired sensation differed systematically among the respondents. The mean desired sensation depended to some extent on the actual sensation, there being a positive correlation in the region from 'neutral' and 'warm' and a negative correlation outside this region. Sensations on the ASHRAE scale are shown to have more than one meaning. Adjusting the ASHRAE scale to allow for the desired sensation yields different distributions of thermal comfort and different group-optimum temperatures. The adjustment should therefore be applied whenever the ASHRAE scale is used. The implications for thermal simulation and for energy use in buildings are considered.

Keywords: Thermal comfort; ASHRAE scale; Desired sensation

1. Introduction

The simplicity the ASHRAE scale of subjective warmth (Table 1) should not lead us to suppose that its interpretation is self-evident or its behaviour invariant. Over the many years of its use in field studies, some quite complex behaviour has been encountered. It was suggested 30 years ago, from comparisons of many field studies, that people in hot climates might prefer a sensation slightly cooler than neutral, while people in cold climates might prefer a sensation slightly warmer than neutral [1]. The need to ascertain more precisely the desired thermal sensation on the scale led researchers to supplement it with a scale of thermal preference [2,3] which asked people whether they would prefer to feel warmer or cooler, or whether they desired no change. Comparing their replies with their responses on the ASHRAE scale enabled any 'semantic offset' in the ASHRAE scale to be detected. Thus, de Dear et al. [4,5] in their meta-analysis of field studies, detected a small climate-dependent semantic offset, in the expected direction, for people in the centrally air-conditioned buildings, but in the naturally ventilated buildings the effect did not reach statistical significance.

More recently, Humphreys and Nicol [6] have shown, from extensive field studies conducted in European offices, as well as from the de Dear database, that the desired sensation on the ASHRAE scale depended not only on the prevailing outdoor temperature, but also upon the current indoor temperature. People preferred, on average, sensations on the warm side of neutral if it was cool outdoors and warm indoors, while they preferred sensations cooler than neutral if it was warm outdoors and cool indoors. This result indicated something of the complexity of the behaviour of the semantic offset of the ASHRAE scale, behaviour relevant to interpreting the results of field studies, and potentially also of laboratory studies. That the behaviour of the scale is complex should be no surprise, for the construction of valid semantic scales is no easy matter [7].

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Table 1
The ASHRAE scale of subjective warmth

Descriptor	Code
Hot	+3
Warm	+2
Slightly warm	+1
Neutral	0
Slightly cool	−1
Cool	−2
Cold	−3

There is also an implication for the estimation of energy use in buildings. If the assumption that optimal comfort can be equated with thermal neutrality is incorrect, then temperature standards based on the ASHRAE scale will also be to some extent faulty, and faulty assumptions about the required temperatures can lead to erroneous estimates of energy requirement.

The 'semantic offset' may be thought of as a moveable 'zero-error' on the ASHRAE scale, whereby the optimum for comfort is not fixed at 'neutral' (zero on the scale), but can take other values.

This paper continues our investigation of the behaviour of the scale, but focuses upon its internal dynamic rather than upon the influences of indoor and outdoor climate. We use a different method: instead of using a conventional scale of thermal preference, such as the McIntyre scale, we asked people, immediately after they had indicated their response on the ASHRAE scale, also to indicate on the scale the place that represented, at that time, their current desired thermal sensation (see Fig. 1). Griffiths [8] had used this method a number of years ago, and it has the merit of providing direct information about the desired sensation whenever the scale is used, whereas the McIntyre scale yields the desired sensation only for those occasions when a respondent desires 'no change'. Thus, when respondents indicated that they would have preferred 'cooler' or 'warmer' on the McIntyre scale, their ASHRAE vote being 'neutral', we cannot say *how much* cooler or warmer they would have liked to have felt, and so the corresponding desired thermal sensation remains inaccessible. Further, because of the considerable width of the 'no change' zone on the McIntyre scale, the fix on the corresponding ASHRAE scale is rather approximate. The direct enquiry method circumvents both these difficulties.

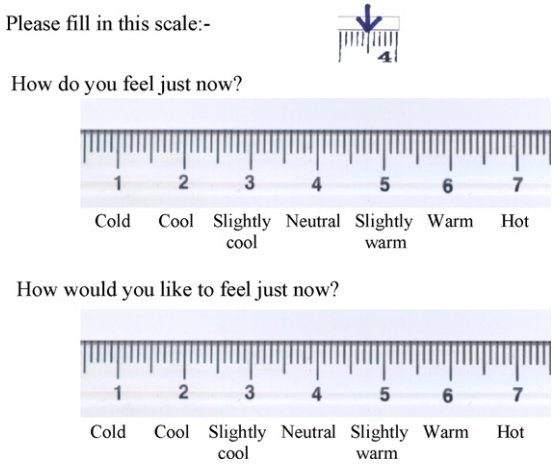

Fig. 1. ASHRAE scale for the double enquiry method.

This paper seeks answers to the following questions:

(1) Using the method of direct enquiry, can it be confirmed that people sometimes prefer sensations other than 'neutral'?
(2) Do people differ systematically from each other in how warm or cool they like to feel? (For example, would some people generally prefer to feel cool, and others warm?)
(3) Does a person have a single preferred sensation on the scale, or does it vary? (For example, does a person sometimes like to feel warm, and at other times cool?)
(4) Is there a pattern that can be discerned? (Might their desired sensation be related to their current actual sensation? Might it be related to their clothing or to their level of activity?)
(5) Do the findings much affect the conclusions to be drawn from a comfort survey?
(6) Do they affect estimate of energy consumption for heating and cooling?

Throughout the paper, it is necessary to bear in mind an important but sometimes elusive distinction. We are talking about how warm or cool the *person feels*, or desires to feel—their subjective response. This is to be distinguished from how warm or cool their *accommodation is*—their objective thermal environment. So we are not exploring whether people differ in the room temperatures they desire, for it is well known that they do. Rather we are exploring whether, at their respective desired room temperatures, they might describe their bodily sensations differently on the ASHRAE scale.

2. Obtaining the data

For an exploration of the interior dynamic of the scale, it was not necessary to choose respondents by representative sampling, nor thermal environments strictly representative of the respondents' thermal experience, and nor was comprehensive measurement of the thermal environment required. We did, however, wish to cover a wide range of responses to the ASHRAE scale, and to have repeated observations on a number of respondents. Two projects were being conducted in the Oxford School of Architecture, and we were able to include in them a direct enquiry into the preferred point on the ASHRAE scale.

2.1. Students during lectures

The first project concerned the thermal comfort of students during lectures. The students (first year architecture course) were invited to complete a brief questionnaire, both at the beginning and towards the end of hour-long classes in an air-conditioned lecture room. They gave their thermal sensation on the ASHRAE scale, and also indicated what their desired sensation would have been at that time (Fig. 1; see also Appendix A). The procedure was repeated for five lectures during February and March of 2004, and a total of 133 students took part, but few attended all five lectures. This yielded 298