Relations Between Personal Characteristics and Bioclimatic Comfort

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1. INTRODUCTION

Interactions between personal characteristics (clothing, age, gender, behaviour, among others), atmospheric conditions and bioclimatic comfort (understood here as resultant of both thermal comfort and mechanical comfort) are complex and can be seen in two different ways: the personal parameters, together with the atmospheric conditions, influence bioclimatic comfort, but, at the same time, the way people feel the atmospheric elements can change, for example, their clothing and their behaviour, mainly through an attempt of adaptation to the atmospheric conditions, to attain a more comfortable state or to use more favourably the potentialities of the weather state. The traditional models and indices used to assess thermal comfort (as PMV or SET*), are not suitable to that study, because they where developed mainly to the use in indoor and steady-state conditions, with low human and climatic variability and because they don't consider psychological and environmental factors (Höppe 2002; Ahmed 2003; Nikolopoulou and Steemers 2003; Stathopoulos et al. 2004; Knes and Thorsson 2006; Oliveira and Andrade, 2007).

The relation between these 3 groups of parameters (atmospheric, personal and level of comfort declared) were investigated in a sample of nearly 1000 interviewed persons, in two open spaces of Lisbon (Portugal – fig. 1), in all seasons. All the relations were tested statistically[2].

2. METHODS

The field work to collect the data was based on simultaneous inquiries and weather parameters measurements (fig. 2). Circa 1000 persons were interviewed in two open spaces of Lisbon, and, at same time and place, measurements of air temperature, relative humidity, wind speed, solar and infra-red radiation were performed. Mean radiant temperature was calculated from solar and infra red radiation, using the method described in Jendritzky and Nübler (1981); different thermo-physiological indices were also calculated using the Software Rayman (Matzarakis et al., 2007).

The inquires were made only to people aged above 16 years old, engaged in leisure activities of low physical intensity. In the inquiry (Oliveira and Andrade, 2007) different questions were asked about, on the one hand, the personal characteristics of the interviewee and, on the other hand, his/her perception of the thermal environment and level of comfort. Clothing was evaluated based on the method described in Oliveira and Andrade (2007) and afterwards quantified in Clo units, based on Parsons (1993). Clothing in the sample varied between 0.24 and 1.75, with an average value of 0.73.

In the data analysis, different statistical methods (namely linear regression, ANOVA and the chi-square test) were used to try to understand the relationship between personal factors, atmospheric conditions and declared comfort (fig. 3). All the results were tested and only the significant ones were analysed.

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3. RESULTS

The age of the interviewees is an important control factor on preference votes; in general, declared discomfort decreases with increasing age, either for thermal or wind conditions (Fig. 4). Gender is also an important factor, but only to wind preferences: women had a smaller acceptability to wind speed than men (fig. 5). It is important to say that the best relation of declared comfort with wind was not obtained with wind speed, but with an index that combined wind speed and variability (Vx = vmax + vdp).

There is apparently no influence of clothing in the thermal or wind preferences declared by the interviewed persons, most probably because the clothing thermal insulation is strongly dependent on the thermal and wind conditions of the day; in a multiple regression model, air temperature and wind speed in the meteorological station of the central area of Lisbon at 12 p.m. on the days of the field sessions explain 67% of the variance of CLO; when adding the mean monthly temperature to the model, which represents the seasonal component, the explained variance increased to 69%.

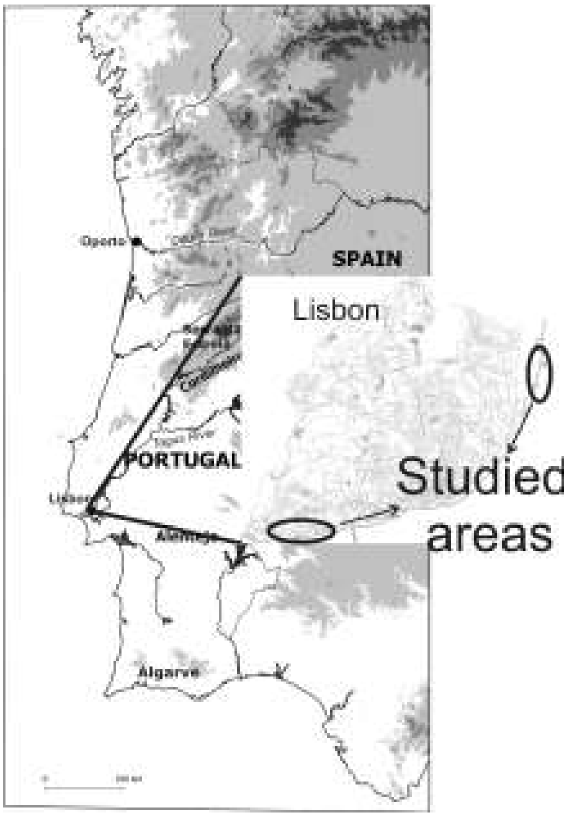

Fig. 1. Lisbon and the studied areas

Fig. 2. Inquiries and radiation measurements

Geographic origin can be an important factor to thermal comfort, because of the difference in the thermal adaptation to local conditions. From the interviewees coming from outside Portugal, only Brazilian people (that constituted 3.5 % of the sample) showed a clearly difference in preference votes, relatively to people with Portuguese origin, and only relatively to cool conditions (fig. 6). 55.5 % of Brazilians declared to prefer a higher temperature, against 30% of Portuguese. This difference is significant, with $p < 0.05$. No significant difference was found between the other geographic groups (African; European tourists) and people born in Portugal).

Many of the personal factors commonly associated to thermal comfort do not present a significant relation with preference votes, maybe because of the specific characteristic of the sample or of the local conditions, a relation between thermal preference votes and an aspect of the social behaviour was found: to be alone or not. People who were alone felt more uncomfortable in almost all classes of temperature, except with the higher values (above 28ºC –

fig. 7). The difference is significant ($p< 0.001$). With the highest temperatures, there is even a change in the general direction of votes of the people alone.

4. DISCUSSION

The referred influence of age (decrease of discomfort with increasing age) reflects two factors: in the first place, there is an increase of clothing insulation with increasing age (mean clothing insulation under 25 years old was 0.64 Clo; above 65 years old, it increased to 0.85 Clo). But this difference explains only the less sensitivity to cool conditions, and older people also showed a larger tolerance to warmer conditions; this can be related to a minor sensitivity of older people to temperature variations, mentioned by some authors (Parsons, 1993; Frank et al., 2000)

In traditional thermal comfort models, clothing is integrated as one of the variables that affect the energy balance of the human body and hence, the thermal comfort. This is theoretically correct, but, as clothing is easily changeable, there is always an adaptation of clothing to thermal conditions; therefore, clothing was never a factor of discomfort in the studied conditions (always in leisure situations); maybe in other kind of conditions, when there is an obligatory clothing system (a uniform, for example), the results could be different.

Influence of geographical origin (that is thermal adaptation) was confirmed only in the case of Brazilian people; they were in general people working in Portugal for a short time (but the exact period was not answered), so, we can presume that they were not yet adapted to cool conditions; it is interesting to see that these people do not show a larger tolerance to warm conditions than Portuguese, but the sample is maybe too small to deepen this question. When considering other groups (African, European tourists), the lack of conclusions can also be due to the small dimension of these groups in the sample, but also to the fact that the inquiry is not sufficiently detailed in relation to these questions (time of permanence in Portugal; exact place of origin abroad).

In opposition to the previous analysed factors, whose influence in thermal comfort can be partly (or totally) physiological, to be alone or not seems to have a purely psychological influence in the perception of the atmospheric environment. Even though these factors are generally difficult to identify, it was possible to find a significant statistically relation with thermal comfort. This relation is not maintained in the warmest class (Fig. 7) but these results need a supplemental analysis.

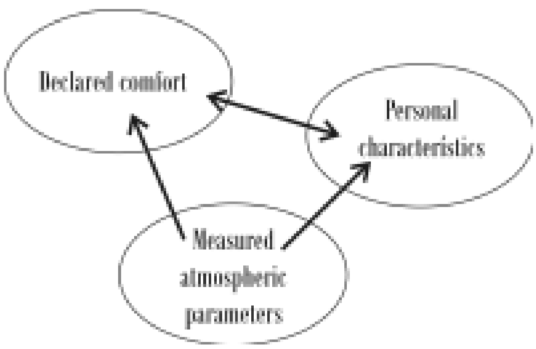

Fig. 3. Type of relations analysed (based on Oliveira and Andrade, 2007)

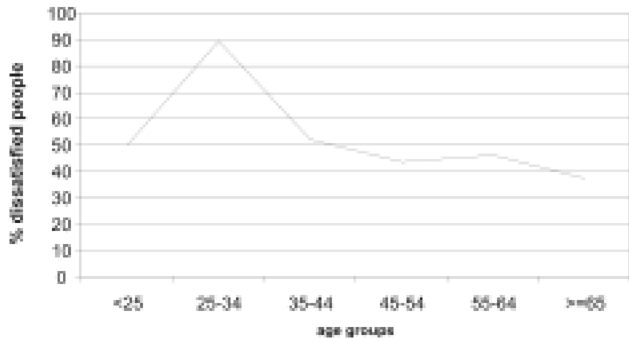

Fig. 4. Change in comfort with age

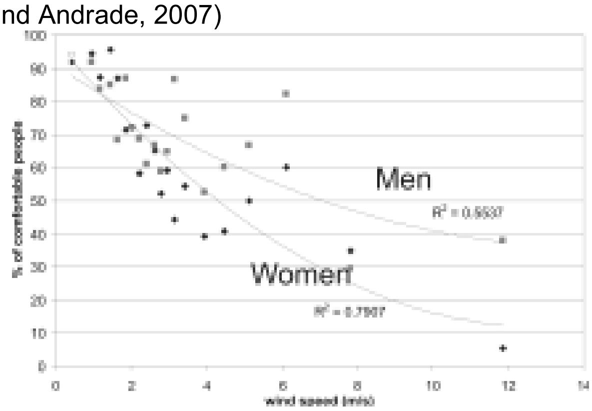

Fig. 5. Influence of gender in wind comfort

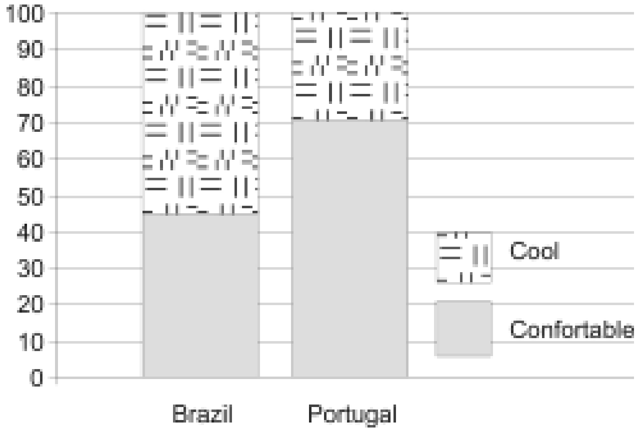

Fig. 6. Differences in comfort between Brazilian and Portuguese people

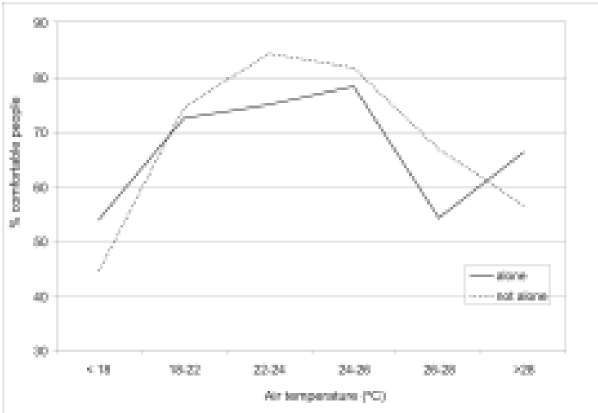

Fig. 7. Influence of being alone or not in the declared thermal comfort

5. CONCLUSION

The importance of different personal characteristics in the bioclimatic comfort was confirmed; the strongest relations were observed with age and gender, but there were also influences (weaker but still significant) of the geographical origin and of different behaviour features (such as being in the shade or in the sun and being alone or not). Furthermore, it was observed that atmospheric conditions can lead to changes in clothing and behaviour. This analysis intended to contribute to a better integration of personal parameters in the models of bioclimatic comfort and, additionally, to increase the understanding of the consequences of the weather conditions on human behaviour.

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