MEASUREMENT OF PERCEIVED COMFORT PROPERTIES OF DOUBLE KNITS

Kyunghi HONG and Soo-Kyung JUNG
Department of Clothing and Textiles
Chungnam National Univ., Taejeon 305-764, Korea

INTRODUCTION

Perceived responses evoked from clothing stimuli are critical in the subjective assessment of clothing comfort. There have been a great deal of works on subjective comfort judgement, usually by Likert type vote on the rating sheet composed of a list of comfort attributes expressed as adjectives. HPA(Human Perception Analysis) developed by Hollies et al.(1) introduced a new method on the construction of psychological scale of measurements by using actual words through the preliminary interview with prospective raters. Prior works (2,3) have demonstrated that clothing comfort studies using 'HPA' can provide us with the information on the realistic images of the product performance as perceived in the brain of wearers.

In spite of actual contribution of the HPA method to sensorial comfort studies, more consideration should be given to the construction of attribute descriptors in the rating sheet to have a more standardized method for subjective evaluations. The scope of our study includes methodology development of the construction of rating sheets as well as actual performance evaluation of the double knit system. The double knit structure was chosen since there still remain controversies over the skin-contacting fiber type in the double knit construction (4,5).

The purposes of this study were: firstly, to find out sensorial dimensions that elicit overall comfort sensation based on the language by peers, secondly, to construct a more powerful rating sheet which includes both necessary and sufficient attributes representing the corresponding dimension of sensation, thirdly, to investigate the effect of the skin-contacting fiber type(cotton and polypropylene/cotton blend) in double knits on the subjective sensation and microclimate. The effect of vapor permeable water repellent outerwears(polyurethane coated nylon) over the experimental double knits on the sensorial comfort and microclimate was also tested.

METHODS

Sensorial evaluations were basically followed by tbe HPA approach. To collect descriptors, 144 consumers were interviewed preliminarily. Based on the frequency, 21 descriptors were included in the rating sheet. Twelve young female subjects were followed by a rest-exercise-rest protocol in a conditioning room (28 "C, 75% RH). During the test, they responded to each descriptor using a seven-point scale at each stage of the rest-exercise-rest protocol while wearing two kinds of double knit sleeves with and without vapor permeable water repellent outerwears. Two kinds of sleeves were constructed using the same kind of double knits by turning inside out to control other effects besides the skin-contacting fiber type. Total fiber compositions of the double knit were 72% cotton and 28% polypropylene. However, one side was made of cotton except binding yarns and the other side was made of the blend of polypropylene and cotton(1:1). At the same time, temperature and % RH at the microclimate between the forearm and sleeves were also measured continuously using a data acqusition system. The principal factor analysis with varimax rotation was applied to the total data set of 288 (12 subjects x 3 stages x 2 fiber types x 2 outerwears x 2 repeats) obtained from 21 descriptors.

RESULTS

Subjective comfort sensation of the tested double knit with and without outerwears was composed of five dimensions which can be labeled as thermal sensation, contact sensation due to sweat secretion, fit, weight, easy of movement, respectively. Out of 21, 19 descriptors showed factor loadings larger than 0.5. In Table 1, important two dimensions and their descriptors along with the factor loading, frequency used by 144 prospective users, and sensitivity ratio(2) are compared. Attributes which have higher factor loadings at each dimension of comfort are not necessarily matched to the descriptors used more frequently by users or to sensitivity ratio. For example, even though interviewed wearers did not use the descriptor 'muggy' frequently, the factor loading and sensitivity ratio were very high. It is noted that 'muggy' or equivalent terms to the combined sensation of 'hot and humid' should be included in the rating sheet to differenciate comfort performance evaluation of the active wear composed of double knits and outerwears.

Subjective assessment of the skin-contacting fiber type and presence of outerwears using selected descriptors on a seven-point scale is tabulated in Table 2. The effect of outerwears on the subjective sensation

showed significant differences at $p < 0.05$. Differences between skin-contacting fiber types were not significant at $p < 0.05$. However, subjects consistently rated pp/cotton blend as slightly more comfortable. In terms of the overall comfort sensation, subjects also rated pp/cotton blends as more comfortable, which was well matched to the result of each descriptor.

Microclimate measurements using commercial humidity sensors for the clothing microclimate (accuracy: ±3% RH) did not show any trend depending on fiber types. Statistical significance was found only in the outerwear variables. The lack of statistically significant differences between fabrics can be explained in terms of the small differences in the fiber composition between cotton and pp/cotton blend and also relatively dry condition in the microclimate. The exercise level imposed on the subjects was light, so that the mean temperature and humidity in the microclimate were 34.6°C and 64% RH, respectively, even after the exercise. This condition may not enhance the sensitivity of subjects' sensation sufficiently.

Table 1. Further analysis of some comfort descriptors based on factor analysis, factor loading, frequency used by wearers and sensitivity ratio.

Factor	Descriptor	Factor Loading	Frequency	Sensitivity Ratio
Factor 1: Thermal Sensation	muggy	0.75	9	3.05
	stifling	0.74	17	3.40
	hot	0.70	48	3.15
	unpleasant	0.60	27	2.84
Factor 2: Contact Sensation due to Sweat	damp	0.72	38	2.42
	clingy	0.63	19	2.67
	non-absorbent	0.51	22	2.71

Table 2. Subjective assessment of the skin-contacting fiber type and presence of outerwears using selected descriptors on a seven-point scale.

Descriptor	Skin-contacting fiber type		Outer wear	
	PP/Cotton	Cotton	Yes	No
muggy	5.10	5.10	5.55	4.65
stifling	5.19	5.25	5.63	4.82
hot	5.22	5.30	5.70	4.81
unpleasant	4.63	4.66	5.17	4.12
damp	4.23	4.31	4.60	3.94
clingy	4.38	4.44	4.81	4.01
non-absorbent	3.83	3.86	4.16	3.53

CONCLUSIONS

It is noted that the term representing a combined feeling of thermal and wetness sensation, for example, muggy, appeared to he a powerful language to measure perceptual responses of human subject, although the ordinary users did not use the term very often. Therefore, in the construction of a psychological scale in rating sheets, care should he taken to include descriptors which have higher factor loadings to represent the corresponding dimensions as well as higher frequency. Sensitivity ratio may also serve as another criterion to select the descriptors along with the frequency. As for the comfort properties of double knits, it seems that subjects prefered pp/cotton blend to cotton as the skin-contacting fiber type, though the result was not statistically significant at $p < 0.05$ in this experimental condition.

REFERENCES

1. Hollies, N. R. S., Custer, A. G., Morin, C. J. & Howard, M. E., 1979, A Human Perception Analysis Approach to Clothing Comfort, *Text. Res.* J., 49, 557-564.
2. Hollies, N. R. S., 1989, Visual and Tactile Perceptions of Textile Quality, *J. Text. Inst.*, 80,1-18.
3. Hyun, S. O., Hollies, N. R. S. & Spivak, S. M., 1991, Skin Sensations Perceived in Apparel Wear, pt.1.:Development of a New Perception Language, *J. Text. Inst.*, 82, 389-398.
4. Umbach, K. B., 1988, Physiological Optimization of Textiles for Sportswear and Workwear, Proc. Int. Symp. Clothing Comfort Studies in Mt. Fuji, 123-148.
5. Tsuchida, K. T. et al., Simulation Equipment for Micro-climate within Clothing and Its Application in Product Design Planning, ibid., 169-190.