ASSESSMENT OF FABRIC COMFORT BASED ON FINGER SENSITIVITY

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ABSTRACT

Assessment of fabric tactile comfort by humans is subjected to many influencing factors including finger sensitivity of the assessors. In previous research, a group of panel members with finger sensitivity between 0.60 to 1.80 mm discrimination performance were selected to perform a fabric handle measurement. A tool called JVP Domes was employed for the measurement of finger sensitivity. In this work, we aim to analyze the influence of the range of finger sensitivity towards the fabric handle assessment. Three groups of assessors based on their finger sensitivity were formed i.e. 0.60-1.00, 1.01-1.20, and 1.21-1.50 mm, in order to investigate the consistency of the results for the measurement of smoothness, softness and warmth attributes. No significant differences were found between the scores from the three groups. This proves that sensitivity up to 1.50 mm is acceptable for assessors. We propose that the selection of panel members based on finger sensitivity is the best way to select people for tactile related assessment, as opposed to other methods.

Key Words: fabric handle, subjective assessment, sensory assessment, JVP Domes, fabric comfort

1. INTRODUCTION

Fabric tactile comfort assessment prominently relies on the feel of human. The human assessment is usually subjected to many influencing factors especially related to the assessors such as age, gender and nationality, expert or novice type of assessors, or testing procedures i.e. blinded or non-blinded procedures, touch methods etc. Several researchers found that the spatial acuity of touch depreciates as we get older [1,2]. Some also mentioned that the preference of a fabric is different between assessors of various origins. For instance, Japanese assessors prefer stiffer fabrics for lightweight summer materials, as compared to Australians, New Zealanders and Indians [3].

In the previous research from the authors of this paper [4], a group of panel members with finger sensitivity between 0.60 to 1.80 mm discrimination performance were selected to perform a fabric handle measurement. The sensitivity was tested with JVP Domes, a kit to measure spatial acuity of skin surface [5]. A pool of human panel members consisting of males and females, experts and novices, aged 23 to 56, with different ethnicity or nationality i.e. Asians, Europeans and Africans, were the subjects in our study. The research found no significant origin, gender or age-based difference on the judgements for smoothness, softness and warmth [4]. The literatures reported that the average range of normal people is 0.98-1.22 mm [5–8]. Hence, the range used in the study (0.60-1.80 mm) can be considered satisfactory, though wider than the average range. It allows for a bigger pool of people to be included in a panel. Therefore, as an extension to the study [4], in this current work, we aim to analyze the influence of the range of finger sensitivity towards the fabric handle assessment. Hence, several groups of assessors with different finger sensitivity are introduced. Their performance on rating the fabrics is compared and analyzed.

2. MATERIALS AND METHODS

This work utilizes 13 non-homogenous fabrics consisting of cellulosic, wool, polyester and polyamide with woven and knitted structures. The mass per unit area of the fabrics (EN 12127:1997) varied between 122 – 157 g/m^2 and their thickness between 0.26 to 0.66 mm (EN ISO 5084:1996). Table 1 shows specifications of the fabrics. The selected fabrics are in the typical range of apparel clothing fabrics.

Table 1. Specification of the materials

Fibre composition	Fabric ID	Mass per unit area (SD), g/m^2	Yarn linear density (Tex)		Fabric density (warp/ wale x weft/ course per cm)	Thickness (SD), mm	Fabric construction and finishes
			Warp/ wale	**Weft/ course**			
100% Tencel®	A-knit-tencel	125 (2.60)	20/1	20/1	13x16	0.60 (0.02)	Knitted -Single jersey Washed on frame, no additional treatment.
50/50% cotton/Tencel®	B-knit-co/tencel	152 (0.88)	20/1	20/1	14x20	0.64 (0.02)	
100% Modal®	C-knit-modal	140 (0.63)	20/1	20/1	14x20	0.51 (0.01)	
100% cotton	D-knit-co	157 (2.21)	20/1	20/1	15x20	0.66 (0.01)	
100% micro Modal®	E-knit-µmodal	155 (1.63)	21/1	21/1	15x20	0.57 (0.02)	
100% micro Modal®	F-wov-µmodal	134 (0.63)	10/1	10/1	78x51	0.27 (0.00)	Woven - Satin 5/3 Desized and washed, no additional treatment
100% Tencel® micro	G-wov-µtencel	136 (0.61)	10/1	10/1	77x51	0.27 (0.02)	
100% cotton	H-wov-co	135 (0.84)	10/1	10/1	75x58	0.32 (0.02)	
100% Lenzing Modal®	I-wov-modal	138 (0.46)	10/2	10/2	78x53	0.27 (0.01)	
100% Tencel®	J-wov-tencel	131 (0.35)	10/1	10/1	77x52	0.26 (0.01)	
*100% wool	K-wov-wool	122 (1.16)	30/2	30/2	21x18	0.30 (0.01)	Woven – Plain weave, no additional treatment
*100% polyester	L-wov-PET	132 (0.43)	34/2	24/1	25x20	0.34 (0.01)	
*100% polyamide	M-wov-PA	150 (1.62)	44/2	22/1	22x20	0.43 (0.02)	

*adjacent fabrics used in testing of colour fastness (the specification are controlled according to ISO 105-F01/F03/F04:2001 standards.

JVP Domes are used to measure the finger sensitivity of the panel members. It is a kit consisting of eight plastic gratings with equidistant bars and grooves width of 0.35, 0.50, 0.75, 1.00, 1.20, 1.50, 2.00 and 3.00 mm, respectively, see Fig. 1. This tool is more commonly used for research on clinical patients who have impaired touch sensory [9,10]. In random order, the examiner will press the eight gratings (one at a time) in any of two orthogonal directions on the fingers of the assessors who are blindfolded throughout the test. Then, they need to respond to the examiner about the direction of the bars and grooves as what they perceived. The finer the bars and grooves are, the harder it normally becomes for the assessors to feel the directions of the grooves.

The test is repeated 20 times. Then the grating gap or bars/grooves width that yields a threshold performance of 75% correct discrimination (g_{75}), i.e. halfway level between chance and perfect discrimination, is determined as given by

$$g_{75} = g_{low} + \frac{(0.75 - p_{low})}{(p_{high} - p_{low})} (g_{high} - g_{low}). \quad (1)$$

Here, g is the grating spacing, p is correct trials/number of trials, g_{high} and g_{low} denote to the highest and lowest grating spacing on which the patients or assessors in our case responded correctly better and worse than 75% of the time, and p_{high} and p_{low} are the probability of correct response on g_{high} and g_{low}, respectively [5]. In this research, we only select the assessors with g_{75} in the range of 0.60-1.50 mm.

We divide the sample group in three smaller groups of assessors i.e. $g_{75} \in (0.60, 1.00)$ the lowest range group $\mathbf{G}_L$, $g_{75} \in (1.01, 1.20)$ the middle range group $\mathbf{G}_M$, and $g_{75} \in (1.21, 1.50)$ the highest range group $\mathbf{G}_H$, this in order to investigate the consistency of the results from the group of lower and higher sensitivity range. Six assessors are present in $\mathbf{G}_L$, 11 are present in $\mathbf{G}_M$ and seven in $\mathbf{G}_H$.

Figure 1. JVP Domes gratings

Three fabric bipolar attributes i.e. smooth-rough, soft-hard and warm-cold are tested on the fabrics by 24 human panel members. These three attributes are often used to explain the judgements made on fabric handle. The assessment uses blind-rate method in which the assessors needs to be blind folded to avoid any visual influence. Since the samples are large (> 10 samples), the assessment is conducted in two split sessions. Through a pair of reference samples that are used in both sessions, the results of both sessions can be linked. The details about the method is discussed in [4].

3. RESULTS AND DISCUSSION

Kendall's Coefficients of Concordance (W) analysis was conducted to determine the consistency of the human assessment results [11]. Since this analysis is designed for ranked data, we should first convert the rates into rank using a straightforward conversion. The results on the analysis for inter panel members give W>0.5 with p<0.05 for the tested attributes which indicate a significantly consistent assessment amongst the panel (see Table 2). We also verified the concordance between the score given by each panel member for all three attributes. No concordance was found (W<0.5, p>0.05) which means that the scores for smoothness, softness and warmth given by the panel members are not related to each other. In other words, no specific internal traits of the fabrics e.g. thickness or weight, influenced the way panel members evaluate the samples overall.

Next, an analysis of variance (ANOVA) was executed on the results from the panel members from the three groups of finger sensitivity. The results yield p>0.05, allowing us to reject the null hypothesis, or in other words, showing good agreements between the groups of highest, middle and lowest sensitivity. We also noticed a uniformity in results for all three tested attributes for all the cut-off points introduced. Fig. 2 shows the mean value plots of the assessment results, with the error bars indicating the standard variation.

Table 2. Kendall's consistency test result

	smoothness	softness	warmth
Kendall's W	0.68	0.89	0.56
p-value	< 0.001	< 0.001	< 0.001

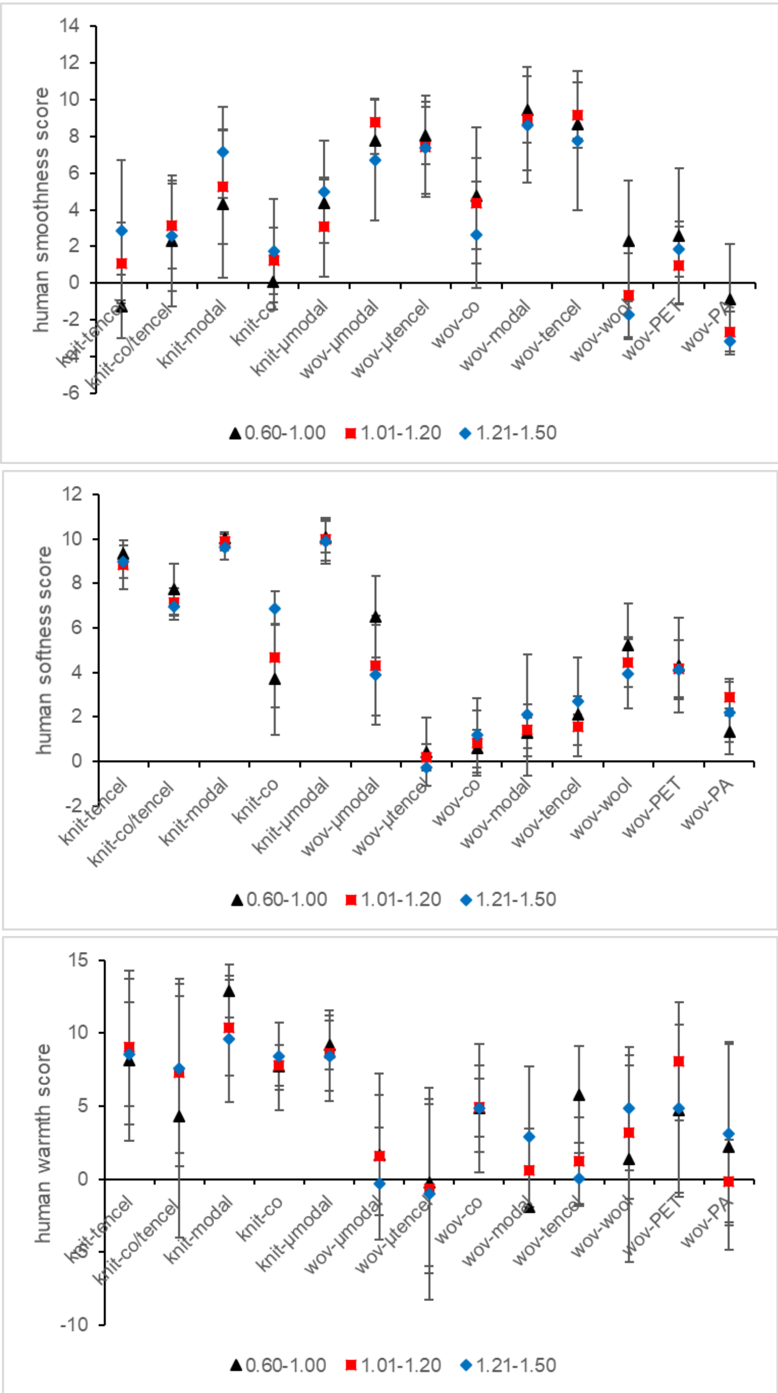

Figure 2. Mean scores for smoothness, softness and warmth from the results of human panels

Based on the plots, no distinct trend can be seen for any group of finger sensitivity. The scores for certain fabrics e.g. woven micro Tencel®, woven cotton and knitted micro Modal® are close to each other as given by the panel members, especially in softness evaluation. However, clear differences can be seen for woven wool, PET and PA for smoothness assessment in which the assessors with lowest range of finger sensitivity have rated the fabric smoother than the other groups of assessors. The scores for warmth property of woven fabrics also seem disparate between the groups of assessors for some samples. However, large error bars indicate also high disagreements between assessors of the same sensitivity group.

A study comparing the human warmth assessment with an objective measurement by Fabric Touch Tester also showed a poor correlation between the two methods [12]. This suggests the lack of understanding of the property and testing procedures especially on the protocols for human assessment. Nevertheless, in general, no clear pattern on which group of panel members perceived the fabric smoother-rougher, softer-harder or colder-warmer can be seen, as validated by the ANOVA results mentioned earlier. A discussion based on ethnicity, age and gender of the assessors can be found in the previous research paper [4].

4. CONCLUSION

24 panel members, clustered into three different finger sensitivity groups i.e. 0.60-1.00 (lowest range, highest sensitivity), 1.01-1.20 (middle range), and 1.21-1.50 mm (highest range, lowest sensitivity), were asked to assess 13 fabrics for three attributes i.e. smoothness, softness and warmth. The scores given by each group were compared. Based on the findings, no distinction of the results was observed for the three groups.

The findings also suggest that the introduced selection of the sensitivity g_{75} of panel members within 0.60-1.50 mm is correct, as also the higher values can still be considered a normal range of finger sensitivity that can discriminate comfort attributes in accordance to the more sensitive people. We conclude hence that our range is a good range to consider when selecting people for sensitivity tests.

Finally, it can be concluded that the selection of human panels by their finger sensitivity can generally be regarded as a better option than the selection based on questionnaire, gender or age especially for tactile assessment.

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