Development of a Textile Sensibility Evaluation System

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Abstract

The present study developed a computerized system which can be used to evaluate the visual, tactile, visual-tactile, and auditory sensibilities of textiles and examined its effectiveness in visual sensibility evaluation compared with the traditional paper-based evaluation method. The textile sensibility evaluation system has capabilities of managing information of textile properties, designing a sensibility evaluation study, administering a sensibility evaluation study, and managing evaluation data for post hoc analysis. The test-retest protocol was administered with a within-subjects design for 15 females in their 20s and 30s to examine the difference in visual sensibility evaluation between the paper-based and computer-based methods. A high correlation (r = .88 ~ .97) was found in sensibility evaluation between the two methods and the computer-based system showed a higher repeatability within a rater in repeated evaluation (a decrease of 25% in intra-rater SD), which indicates the computer-based method is an effective alternative to the paper-based method in visual sensibility evaluation.

Keywords: sensibility evaluation, computerized system, similarity in evaluation, intra-rater repeatability

1. Introduction

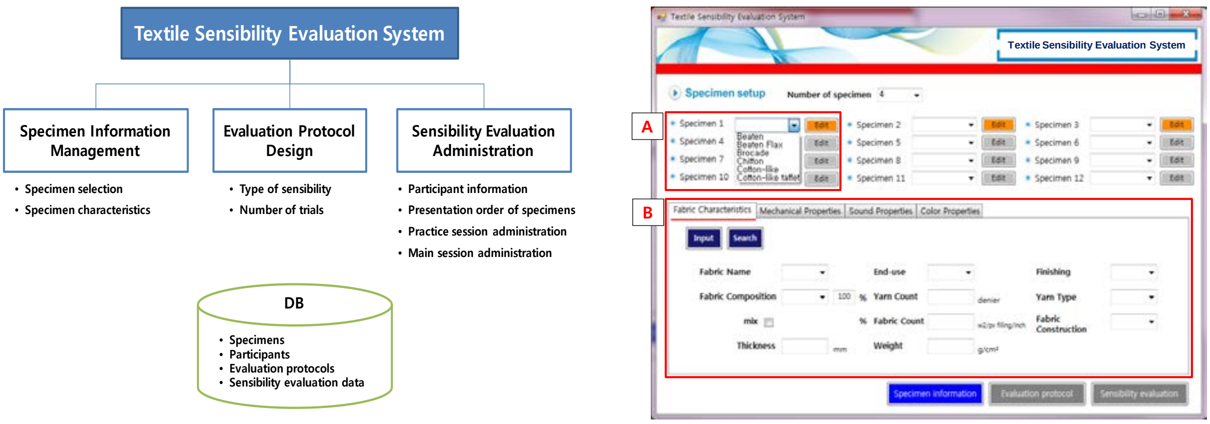
As customers' needs of sensible clothing have drastically increased, research for clothing design considering various aspects of sensibilities has been actively conducted. Chang et al. (2010) suggested preferred scouring methods for naturally colored organic cotton (NaCOC) fibers for various visual sensibility pairs (e.g., bright-dark and luxurious-cheap) by conducting a visual sensibility evaluation on NaCOC fibers of ivory, green, and coyote brown scoured four different methods (NaOH, Na_2CO_3, enzyme, and boiling water). Cho et al. (2001) developed a statistical model which predicts tactile and auditory sensibilities of a fabric such as silk and polyester by using its mechanical and acoustic property information as an input of the model.

Although the paper-based questionnaire method has been commonly employed in sensible textile research to collect sensibility evaluation data from various strata of customers, it still has a significant margin to improve its efficiency in administering an experiment and managing evaluation data. Since the paper-based method is quick and easy to administer, collect, and analyze data, it has been widely adopted in textile sensibility research (Chang et al., 2010; Cho et al., 2001). However, the paper-based method is inefficient in terms of time and manning because the administrator should present specimens and manage evaluation data manually. Thus, efforts are needed to develop a computerized system tailored to textile sensibility evaluation and examine its effectiveness as a valid alternative to the paper-based method.

The present study was intended to develop a tailored computerized system for textile sensibility evaluation and examine its effectiveness by comparing evaluation data obtained from use of the computerized system with those from the paper-based method. To examine the effectiveness of the computerized system, a visual sensibility evaluation experiment on 11 snowflake patterns was conducted in the study by using the paper-based method and the computerized system and their statistical relationships between the two evaluation data sets were investigated.

2. Sensibility Evaluation System Architecture

The textile sensibility evaluation system developed in the present study consists of three modules (specimen information management, evaluation protocol design, and sensibility evaluation administration) as shown in Figure 1.a. As an example, the specimen information management module (Figure 1.a) provides functions to specify textile specimens to be evaluated in a subsequent sensibility evaluation and their fabric, mechanical, sound, and color characteristics (Table 1). If a specimen to be tested is new in the database, a record is created and its detailed characteristics are entered and stored in the database; otherwise, a specimen in the database is selected for evaluation. The information of a specimen in the database is editable and removable.



(a) architecture (b) information management screen

Figure 1. Computerized textile sensibility evaluation system

Table 1. Textile specimen information

Fabric Information	Mechanical Characteristics	Sound Characteristics	Color Attributes
Fabric name	EM (elongation and maximum load)	SPL (sound pressure level)	L
End-use	LT (linearity)	ΔL	a
Finishing	WT (tensile energy per unit area)	Δf	b
Fabric composition	RT (resilience)	Loudness	ΔE
Yarn count	B (bending rigidity per unit length)	Sharpness	C
Yarn type	2HB (moment of hysteresis per unit length)	Roughness	h
Mixed spinning	G (shear stiffness)	Fluctuation strength	
Fabric count	2HG (hysteresis of shear angle φ=0.5°)		
Fabric construction	2HG5 (hysteresis of shear angle φ=5°)		
Thickness	LC (linearity)		
Weight	WC (energy required for the compression)		
	RC (resilience)		
	MIU (mean value of the coefficient of friction)		
	MMD (mean deviation of the coefficient of friction)		
	SMD (mean deviation of surface roughness)		
	T (thickness per pressure 0.5 gf/cm2)		
	W (weight per unit area)		

3. Materials and Methods

3.1. Participants

Fifteen female participants in their 20s and 30s (mean = 27.5, SD = 3.1, range = 24 ~ 35) were recruited in the effectiveness evaluation experiment. They had a normal vision and none of them had color blindness. Their participation was compensated.

3.2. Apparatus

The paper-and-pencil and computerized questionnaires were administered in the visual sensibility evaluation of 11 snowflake patterns (Figure 2). The snowflake patterns were selected by a group of experts in clothing and textiles.

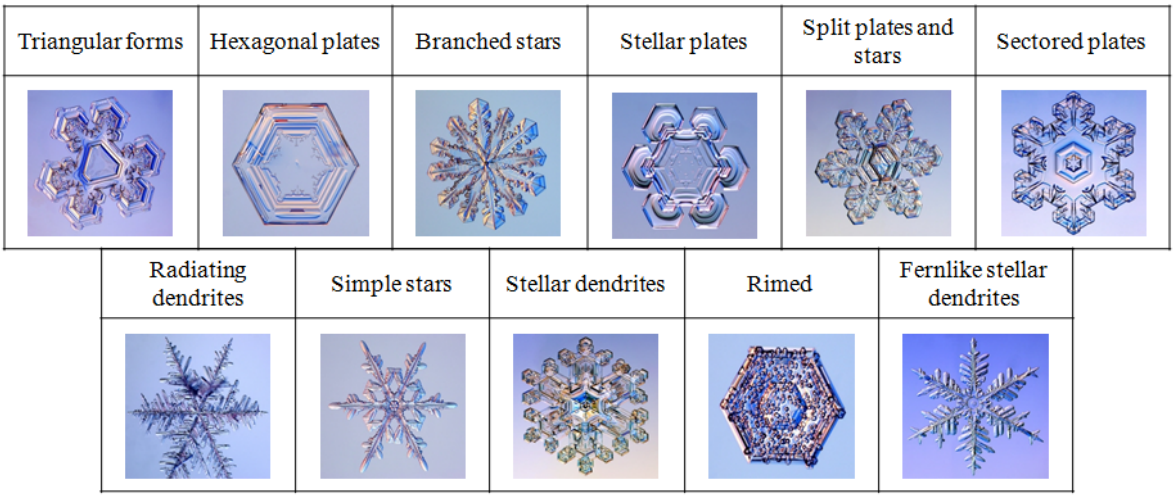


Figure 2. Snowflake patterns used in the experiment

Nine pairs of bipolar visual sensibility adjectives (bright-dark; clear-murky; heavy-light; vivid-subdued; warm-cool; fresh-stale; strong-weak; showy-plain; and luxurious-cheap) were selected for the visual sensibility evaluation of NaCOC from a review of related studies such as Lee & Nam (1999), Oh & Lee (2002), Ou et al. (2004), and Woo & Cho (2003). The specimens were rated using a 7-point scale for each visual sensibility adjective pair (e.g., +3: luxurious; 0: neutral; -3: cheap). In the paper-based method, snowflake patterns printed in color on paper and a paper questionnaire with 10 visual adjective pairs were provided. On the other hand, the snowflake patterns and questionnaire were provided on a computer monitor with a resolution of 1024 × 868 pixels. The lighting condition was controlled at about 400 lux.

4. System Effectiveness Evaluation Results

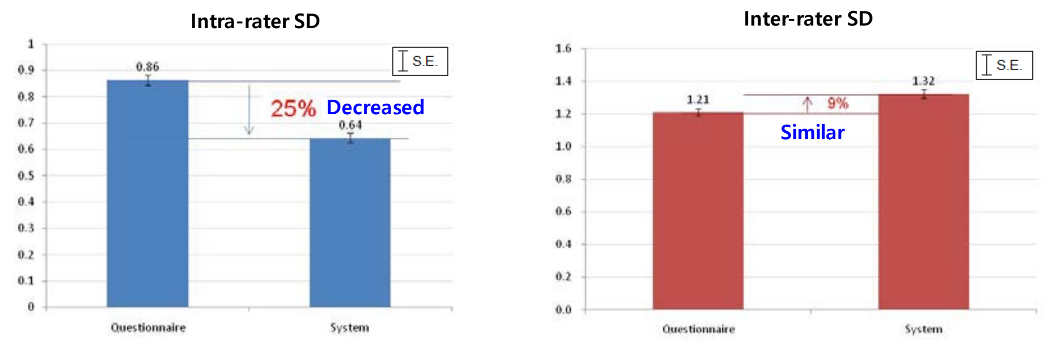
The difference in sensibility evaluation between the traditional method and the computerized system was not found significant by ANOVA and paired t-test. The ANOVA result of the sensibility evaluation in Table 2 indicates that sensibility evaluation is significantly affected at α = .05 by snowflake pattern and sensibility adjective, but not evaluation method. The paired t-test results further shows that the mean differences in sensibility evaluation between the two methods are insignificantly small (-0.22 to 0.07) for all the visual adjective pairs except the clear-murky pair.

The correlation analysis shows that the sensibility evaluations of the two methods are highly correlated (r = .88 ~ .97). Since the sample sizes were large in the sensibility evaluation experiment, Pearson’s correlation analysis was applied. The correlation between the sensibility evaluations of the two methods was above .9 in 9 out of the 10 adjective pairs.

Table 2. ANOVA of sensibility evaluation

Source	*df*	SS	MS	*F*	*p*
Subject (S)	14	711.6	50.9		
Snowflake pattern (P)*	10	2026.9	202.7	14.26	<.01*
P × S	140	1989.7	14.2		
Sensibility adjective (A)*	9	166.5	18.5	8.31	<.01*
A × S	126	280.4	2.2		
Evaluation method (M)	1	22.6	22.6	3.15	.10
M × S	14	100.5	7.2		
P × A*	90	1205.3	13.4	8.51	<.01*
P × A × S	1260	1983.4	1.6		
P × M	10	79.9	8.0	1.63	.10
P × M × S	140	684.6	4.9		
A × M	9	19.9	2.2	1.84	.07
A × M × S	126	151.0	1.2		
P × A × M	90	104.8	1.2	1.25	.06
Error	1260	1173.3	0.9		
Total	3299	10700.3			

Lastly, the repeatability analysis in sensibility evaluation shows that a less variability in repeated evaluation was shown in the computerized system. The SD of sensibility evaluation in two repeated evaluations within each evaluation was reduced by 25% on average as shown in Figure 3.



Method	Intra-rater SD				Inter-rater SD			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Questionnaire	0.86	0.14	0.62	1.07	1.21	0.14	1.04	1.50
System	0.64	0.15	0.33	0.78	1.32	0.10	1.14	1.45

Figure 3. Intra- and inter-rater reliability analysis results

5. Discussion

The computerized textile sensibility evaluation system was developed in the study to complement the inefficiency of the traditional paper-based sensibility evaluation method in administering a sensibility evaluation and managing sensibility evaluation data. Commonly employed in textile sensibility studies such as Cho et al. (2001, 2002), the traditional sensibility evaluation method has inefficient aspects in compiling and analyzing evaluation data. The traditional paper-based method requires a significant amount of time to establish a database by using responses of evaluators (Min et al., 2003). Due to this time inefficiency, the traditional method is practically limited for a product with a short lifecycle time to collect and analyze evaluation data from a large group of evaluators (Cho et al., 2011).

The computerized textile sensibility evaluation system supports evaluation of various sensibilities (visual, tactile, visual-tactile, and auditory sensibilities). The sensibility evaluation system developed by Cho et al. (2011) supports sensibility evaluation on-line by presenting visual images of cellphones with a 100-point scale. The present study identified the possibility of a computerized sensibility evaluation system to replace the traditional paper-based sensibility evaluation method in terms of repeatability and similarity in sensibility evaluation.

Further research has been ongoing to add analysis capabilities such as descriptive analysis to the computerized sensibility evaluation system. The augmented capabilities of the computerized sensibility system will contribute to the efficiency of a sensibility study by supporting the process of data collection, experiment administration, data management, statistical analysis, and analysis information management.

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References

1. Y. Chang, J. Park, W. Hong, and H. You, Analysis of visual sensibility evaluation of naturally colored organic cotton, *2010 Spring Conference of Korean Society for Emotion & Sensibility and Korea-Japan Cooperative Symposium, Jeju, Korea*, (2010).
2. G. Cho, C. Kim, Y. Na, "Effects of basic weave differences in silk fabric and yarn type variations in satin weave on sound parameters.", *Textile Research Journal*, **72**, 555-560 (2002).
3. G. Cho, E. Yi, J. Casali, "Sensory evaluation of fabric sound by free modulus magnitude estimation.", *Research Journal of Textiles and Apparel*, **5**, 29-40 (2001).
4. Y. Cho, J. Park, S. Han, S. Kang, "Development of a web-based survey system for evaluating affective satisfaction.", *International Journal of Industrial Ergonomics*, **41**, 247-254 (2011).
5. B. Min, B. Min, K. Jung, C. Kim, "Development of automatic subjective assessment system using adjectives.", *Journal of the Ergonomics Society of Korea*, **22**, 1-11 (2003).