Analysis of Visual Sensibility Evaluation of Naturally Colored Organic Cotton

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1. INTRODUCTION

Interests in naturally colored organic cotton (NaCOC) increase rapidly in parallel with the social trend of eco-friendly living and wellbeing. The most common colors of NaCOC include ivory, green, and brown (Dickerson et al., 1999). Clothes made from NaCOC are known to be effective in prevention of skin diseases such as atopic dermatitis (Seo, 2007).

A scouring treatment for removal of contaminants and improvement of fabric absorbency change the natural color of NaCOC as well as its physico-mechanical properties (Tzanko et al., 2001). Understanding factors affecting the visual sensibility of fabric color is important to identify desirable fabric characteristics and scouring methods. For example, Ou et al. (2004) reported that the visual sensibility of color significantly varied depending on the cultural difference between evaluators

The present study was intended to identify (1) the intra- and inter-rater reliabilities of a visual sensibility evaluation method and (2) the effects of NaCOC color, scouring method, and age of evaluator on the visual sensibility of NaCOC.

2. MATERIALS & METHODS

2.1. Participants

Thirty females without color blindness were recruited for each of two age groups (20s & 30s; 40s & 50s) in the visual sensibility evaluation of NaCOC. The average ages of the two age groups were 25.8 (SD = 3.3) and 49.3 (SD = 5.7). Their participation in the sensibility evaluation was compensated.

2.2. Apparatus

A paper-and-pencil questionnaire was administered in the sensibility evaluation. 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 in the present study from a review of related studies such as Woo and Cho (2003) and Lee and Nam (2003). A NaCOC specimen was rated for each bipolar adjective pair using a 7-point scale (e.g., +3: luxurious; 0: neural; -3: cheap). Three color sets (ivory, green, and coyote-brown) of NaCOC specimens including one untreated (UT) and four treated specimens (A: CaCO3; B: NaOH; C: enzyme; D: water) were examined in the study.

2.3. Experimental Procedure

The visual sensibility evaluation was conducted by the test-retest method (30 min. of testing and 5 min. of break). The order of evaluation was counterbalanced for the three NaCOC color sets; then, for each color set, the untreated specimen was evaluated first and served as the referent for evaluation of the rest presented in random order. The test-retest method was employed to examine the intra- and inter-rater reliabilities of the sensibility evaluation method. The lighting condition was controlled at 400 lux.

2.4. Statiscal Analysis

The standard deviations of test-retest data within and between participants were calculated to identify the intra- and inter-rater reliabilities, respectively. A four-factor mixed design ANOVA (age, NaCOC color, scouring method, and sensibility adjective pair) were conducted to examine factors affecting the intra- and inter-rater reliabilities. Interactions higher than third order were assumed negligible for practical reasons and post-hoc analysis such as Student-Newman-Keuls (SNK) test was conducted for significant effects.

Next, to compare the sensibility evaluations of NaCOC by age for each sensibility adjective pair, a three-factor mixed design ANOVA (age, NaCOC color, and scouring method) was conducted followed by post-hoc analysis as necessary. All statistical testing was reported at $\alpha = 0.01$ in the study.

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3. RESULTS

3.1. Intra- and Inter-Rater Reliability

The average intra-rater SD ranged from 0.62 to 0.83 without showing any systematic pattern. ANOVA showed only the interaction of NaCOC color and scouring method was significant, and post-hoc analysis found a significantly higher reliability (average SD = 0.62) at the untreated ivory cotton specimen. Next, the average inter-rater SD ranged 0.97 to 1.37 without showing any systematic pattern. ANOVA and post hoc analysis indentified the inter-rater variability changed in a more complex pattern than the intra-rater one.

3.2. Comparison of Sensibility Evaluation

ANOVA found significant main and interaction effects for each sensibility adjective pair. For example, Table 1 indicates all the main and interaction effects of age, color, and scouring method significantly affect the luxurious-cheap sensibility of NaCOC. Figure 1 shows preferred scouring methods differ depending on NaCOC color in the age group 20s & 30s: CaCO3, NaOH, and water for ivory and coyote-brown NaCOC; CaCO3, NaOH, and enzyme for ivory NaCOC. Table 2 further demonstrates preferred scouring methods become slightly different for the age group 40s & 50s: enzyme is least preferred for all the NaCOC colors.

4. DISCUSSION

The present study identified that the inter-rater variability of visual sensibility evaluation was more than one and half times the intra-rater variability and varied in a more complex manner depending on age, NaCOC color, scouring method, and sensibility adjective pair. However, both the sensibility evaluation reliabilities did not show any systematic pattern of changes. The reliability results of the present study can serve as referents for comparison with other sensibility evaluation methods.

ANOVA and post hoc analysis showed that preferred scouring methods for a visual sensibility adjective pair significantly vary depending on NaCOC color and age group. In addition, the study results identified environmentally friendly scoring methods such as enzyme and water could be as effective as chemical methods such as CaCO3 and NaOH.

Table 1 ANOVA results of luxurious-cheap sensibility evaluations

Source	*df*	SS	MS	*F*
Age (A)	1	33.3	33.3	9.7*
Subject (S) [A]	58	199.3	3.4	
Color (C)	2	774.6	387.3	190.6*
A × C	2	22.4	11.2	5.5*
S [A] × C	116	235.8	2.0	
Scouring method (M)	4	351.0	87.8	100.8*
A × M	4	14.5	3.6	4.2*
S [A] × M	232	202.0	0.9	
C × M	8	88.6	11.1	13.7*
A × C × M	8	24.1	3.0	3.7*
S [A] × C × M	464	375.3	0.8	
Total	899	2321.0		

Figure 1 Luxurious-cheap sensibility evaluations of the age group 20s & 30s by NaCOC color and scouring method (UT: untreated A: CaCO3; B: NaOH; C: enzyme; D: water)

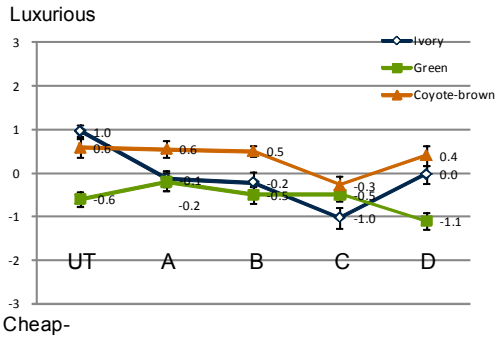

Table 2 Multiple comparison of luxurious (plus) vs. cheap (minus) evaluations by NaCOC color, scouring method (UT: untreated A: CaCO3; B: NaOH; C: enzyme; D: water), and age

Color	Age Group	
	20s & 30s	40s & 50s
Ivory	C (-1.0), B (-0.2), A (-0.1), D (0.0)	C (-0.2), B (0.3), **A (0.5), D (0.7)**
Green	D (-1.1), C (-0.5), B (-0.5), A (-0.2)	C (-0.6), D (-0.3), A (0.1), B (0.2)
Coyote-brown	C (-0.3), D (0.4), **B (0.5), A (0.6)**	C (0.1), B (0.1), A (0.4), **D (0.6)**

(Notes) 1. A horizontal line under scouring methods represents no significant difference in sensibility evaluation. 2. Bolded are conditions of which luxurious sensibility ≥ 0.5.

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