Journal of Applied Sciences

ISSN 1812-5654

science alert

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Journal of Applied Sciences 13 (14): 2639-2645, 2013
ISSN 1812-5654 / DOI: 10.3923/jas.2013.2639.2645

Optimization Design of Female Suit Silhouettes Based on Visual Perception

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Abstract: Fashion design has transformed from production orientation to consumption orientation, with the rise of competition in garment industry. It is important to study consumer's psychology and perception process. In this paper, silhouette of female suits was studied based on information process theory in cognitive psychology and praxiology experiments with E-Prime were carried out to replace traditional questionnaires in Kansei Engineering to calculate the behavior data of subjects. Three silhouette elements (waist, length and hem) of female suits were mentioned and pictures of female suits with different levels of waist, length and hem size were chosen as stimulation samples to examine subjects' sense of fashion. The results showed that the subjects' sense of fashion was significantly influenced and changed regularly with waist, length and hem opening size, of which characteristic silhouette elements were confirmed to have a positive impact on the sense of fashion and the interaction effect of silhouette elements also affected people's perception in evaluating female suits. This work provided behavior basis for studying silhouette element effect on perception of female suit silhouette and would support cognitive neuroscience mechanism in further research. Data results may also provide research basis for evaluation or computer simulation system of fashion design, even product design in other areas.

Key words: Female suits, silhouette, silhouette element, sense, perception

INTRODUCTION

Design process of product has become more and more complex with the development of material and information science in recent years. At the same time, the demand of consumer is becoming personal, humanized and diverse with market competition, so the function of a product is not the only point and the design idea catering to cognitive process of customer is more and more impressed. In order to occupy consumption market it is important for designers to master the style of product whichh is presented by a series of modeling elements through different approaches. If an evaluation system can be established based on the style of products, the design processes will be accelerated, effective and suitable. Style exists in art and design, such as fashion design, architecture design and so on. Nowadays, fashion is no longer the decision of designers, while the preference of consumer is the most important. Furthermore, consumer's emotional need is also indispensable to providing theoretical principles for evaluation system.

Among various kinds of clothing, suits take a high place. Having played an important role in the development history of human clothing, suits are now becoming the best choice of people when they take part in major occasions worldwide. In recent years, with the development of fashion design, suits are very common and important in many ladies' wardrobes, especially for career women. In current fashion climate, traditional suits will be occupying a leading position in fashion market.

Every consumer has his own idea to each product, especially female consumers with more rich sense to fashion, so it is necessary for apparel enterprises to consider how to design fashionable suits for women, as the trend of fashion is important to keep the sustainable development of suit market. Compared with other silhouette elements, silhouette of suit is more important in designing female suits whichh can not only modify figures of women but also make their statures more prominent. In order to design perfect suits for female consumers, silhouette was the emphasis analyzed firstly in this study. Afterwards, female suits of different silhouettes were selected as objects and the consumers including male and female were targeted to analyze how emotional cognition of people varied with silhouette elements of silhouette and changing levels of the elements.

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BACKGROUND

Research on kansei engineering: At present, many product development theories based on consumers are emerging, of which Kansei Engineering from Japan, or sensory evaluation called in other countries, is one of the new research directions. Kansei Engineering originated in late 1970 sec from Japan and has developed a lot since 1990 sec. Difficult to be quantified, the perceptual reflections can be quantified conveniently by using modern computer technology based on Kansei Engineering to develop new products. In other words, Kansei Engineering is both a product development technology based on customers and a technology which translates customers' experiences and intentions into silhouette elements (Nagamachi, 2002). Many researches in fashion design are based on theory of Kansei Engineering, for example, a fresh way of Kansei Engineering theory called Miryoku Engineering in Taiwan has been applied to product design to emphasize "attractiveness" of products. However, existing researches are focused on content-based retrieval such as low-level information and visual features that make it difficult to retrieve and process images according to human high-level Kansei information (Baek *et al*., 2008).

In the theory of Kansei Engineering, the relation between silhouette elements and image words is important, so each element will be drawn out from the product design for analysis in this study.

Research on perception: With the development of Kansei Engineering, the related researches are not only used in tangible product design but also in human-computer interaction interface and robot engineering. The application layer involves many fields ranging from engineering to the mechanism of human brain and perceptive cognition. Under this circumstance, cognitive psychology becomes a new theory orientation linked tightly with Kansei Engineering for studying product design.

Emerging in middle 1950 sec in western countries, cognitive psychology studied people's high-level psychological process including cognitive process, such as attention, perception, representation, memory, thinking and language and so on. "Cognitive psychology is one kind of study on how we get the information from the world, how to turn the information into knowledge and how the information to be stored up and used to guide our attention and behavior" (Anderson, 2009). Modern psychological research shows that cognitive and emotional factors of subjects have a close relation that emotion can affect people's perception, thinking and behavior. Also, more and more scholars who study psychology try to study human psychology from the opposite perspective of how behaviors affect emotion of human (Vernon, 2006; Auer, *et al*. 2005; Granlund, 1999). From the cognitive psychology and information theory, product style recognition is a process of information processing: User compares his own observation with personal experiences and psychology structures and then makes style decision after reasoning and thinking; therefore, if the psychological mechanism of product style recognition is achieved, the computing model and automatic cognition will be constructed. Kansei Engineering just studies people's sense and the relation between silhouette elements and product designs, while cognitive psychology studies how the sense is formed it is a deeper study called psychological mechanism.

Method in the paper: The first step of Kansei Engineering is preparatory experiments and questionnaire is a common traditional method in the experiment whichh is used to collect image words. In this study, the differences between silhouette elements and the element levels are important in fashion designs and each element can be divided into many levels in fashion style. If these levels are all in one questionnaire, the scope of questionnaire will be very large and the data collection will be inconvenient. Moreover, if the details in questionnaire are too much, the attitude of investigator will be hard to control and exactness of the data can not be ensured. Besides these, in order to study cognitive neuroscience of product style recognition in further researches, praxiology experiments are used in the paper instead of questionnaires. Questionnaire was.

E-prime, psychological experiment software is employed based on visual perception. The experimental data can be automatically stored by E-prime and used for preliminarily analysis. It can not only show stimulus in the form of text, image or sound but also provide detailed time information and event details including showing time and the reaction details for analysis. The time accuracy is optimized before psychological experiments and the presence of stimulus is kept synchronous with the screen refresh rate whichh can make the accuracy up to millisecond. This method was also used in classification of color in fashion design based on perception (Jiang and Liu, 2009). Collar types on female's T-shirt fashionable design was also studied based on visual cognition (Qin *et al*., 2009).

BEHAVIOR EXPERIMENTS

Subjects: Young people have a close sense of fashion and most of them like suits when they go into formal working places. In this experiment, female

suits were selected as objects and 64 undergraduates (senior students who were going to work) were selected randomly from different places as subjects with same education experience. The average age of these students was 21.86 years old and they volunteered to participate in this experiment without any boredom.

The preparation of stimulus samples: Purchasing behavior is driven by emotions, so some kinds of emotions can be chosen to represent what customers need about particular apparel. Commonly, consumers are concern about whether the suit is fashionable enough when choosing suits. If the clothing is out of fashion, consumers will not buy it. Many words were collected from questionnaires and the word "fashionable" was used as an emotional word (sensory word) in this paper from the statistic data.

Silhouette elements of female suit mainly involve waist, length, hem, shoulder breadth, shoulder slope and others. In this study, waist, length and hem were studied first and other elements would be analyzed after the characteristic elements were defined. Thus, the visual stimulus samples could be obtained by combining silhouette elements of different waist, length and hem level. In order to facilitate the processing of data, the pictures of female suits were all coded.

CorelDraw graphics software was used to draw female suit images. Effect of silhouette design factors on female suits was the focus in this paper and samples of female suits were not colored to avoid the color influence on the sense of subjects. 6 levels were divided in waist, 10 levels were divided in length based on measurement and 3 levels were divided in hem based on the angle of hem opening.

Before drawing, a body model which could adapt to practical human body was set up and 300 body measurements of female 1.65 meters high were chosen from database. All measurements were collected from statistical data from 2D graphics measured by 3D Body Scanner (Su and Liu, 2009) and the size of female suits in the pictures was strictly conformed to the practical female suits. 6 levels of waist, 10 levels of length and 3 levels of hem were established, respectively as shown in Fig. 1, 2 and 3 according to the practical female measurement and clothing structure rules.

Experiment process: The pictures of stimulus were shown in the center of the 17-inch computer screen with natural light. Before the experiment, the subjects were asked to get familiar with the processes of trial and button operation and then they were required to do preparative tests in several units.

Fig: 1: Female suits with 6 levels of waist, each level in one image

Fig. 2: Female suits with 10 levels of length, each level in one image

Fig. 3: Female suits with 3 levels of hem, each level in one image

The whole experiment consisted of 180 trials. The picture and word were presented randomly and the show time was limited. Subjects were required to make an exact

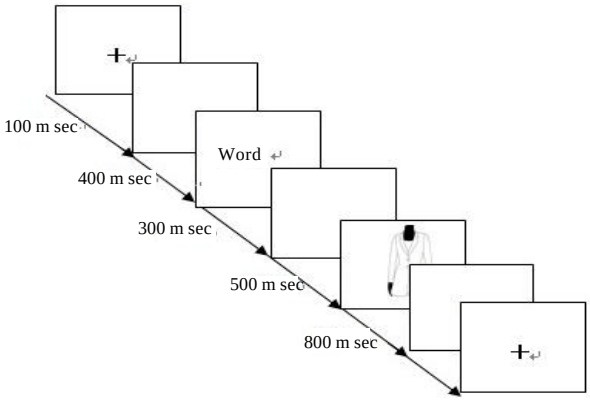

Fig. 4: Task: A schematic illustration of the trial

decision whether their first feeling coincided with the sensory word when seeing female suits in image. If the sense coincided with the word, subjects pressed the specific key in the keyboard; otherwise, they pressed another. The next picture would not be shown until subject made judgment by pressing the keyboard. Data could be collected by E-prime to show reaction time, choices and codes of image. The experimental processes are shown in Fig. 4, where the mark "+" means shielding the sense before the experiment, "word" indicates the sense and "image" is the target.

During the experiment, subjects could be given time to rest and everyone participated once in the same experiment to prevent memory mechanism disturbing subjects' cognitive processes.

Evaluation index: Coincidence percentage was used to be evaluation index. When subjects judging female suit fashionable, the coincidence percentage is 100%, if not, the coincidence percentage is 0. The method of dichotomy can reduce subjects' psychology hardness of task. The coincidence percentage can also show fashionable degree of female suit silhouette.

STASTISTICAL ANALYSIS AND DISCUSSION

In this study, if the sense coincides with the word "fashion" it means subjects judge the female suits to be fashionable. Percentage of sense coincident with the word is the focus of this work and repeated measures ANOVA is applied for discussing the data. Three silhouette elements which have prominent influences on silhouette deigns of female suits are considered an d 6 levels in waist measurement, 10 levels in length measurement and 3 levels in hem measurement are defined in this study.

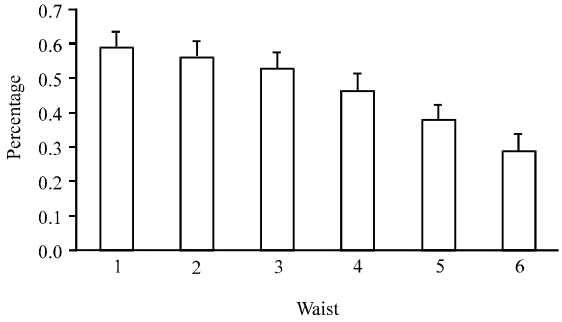

Fig. 5: Coincidence Percentage of subjects judging female suits to be fashionable with 6 levels of waist. Vertical line 1+SE

Discusion in coincidence percentage of subjects judging female suits to be fashionable with 6 levels of waist: Percentages of subjects judging female suits in pictures to be fashionable differ significantly ($F = 29.879$, $p<0.001$) for different levels of waist. Percentage in level 1 is the highest and the value decreases monotonically from level 1 to level 6, as shown in Fig. 5. The behavior results show that waist measurement affects people's judgment for the fashion of female suits significantly and fewer subjects judge the female suits to be fashionable with the increase of waist measurement.

Discussion in coincidence percentage of subjects judging female suits to be fashionable with 10 levels of length: Percentages of coincidence of subjects judging female suits in pictures to be fashionable differ significantly ($F = 18.687$, $p<0.001$) for different levels of length. Percentages in level 1 and level 2 are the highest and the value decreases from level 1 to level 10, as shown in Fig. 6. The behavior results indicate that length size significantly affects people's judgment for the fashion of female suits.

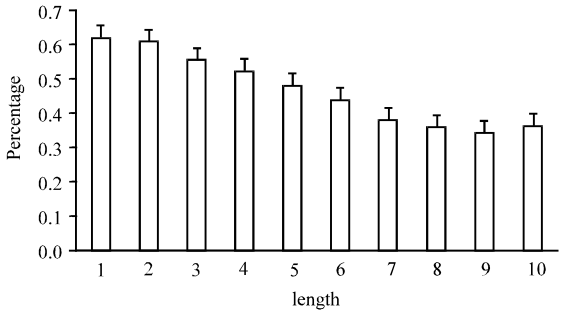

Fig. 6: Coincidence Percentage of subjects judging female suits to be fashionable with 10 levels of length. Vertical line 1+SE

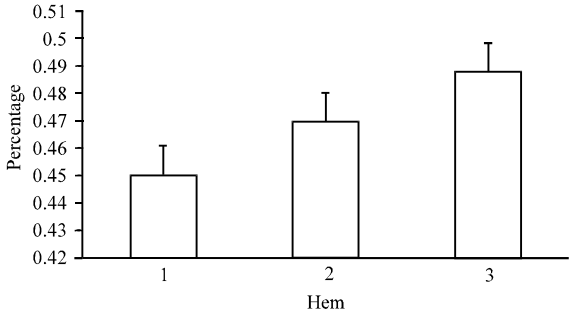

Fig. 7: Coincidence Percentage of subjects judging female suits to be fashionable with 3 levels of hem opening. Vertical line 1+SE

Discusion in coincidence percentage of subjects judging female suits to be fashionable with 3 levels of hem opening: Percentages of subjects judging female suits in pictures to be fashionable differ significantly ($F = 7.054$, $p<0.005$) for different levels of hem opening. Percentage in level 3 is the highest and the value increases from level 1 to level 3 as shown in Fig. 7. The behavior results show that hem opening size affects people's judgment for the fashion of female suits significantly, so it is important for designers to consider the element of hem opening in design processes.

Interaction effect of silhouette design elements changing: By analyzing coincidence percentages of judging female suits in pictures to be fashionable, a 6×3×10 repeated measures ANOVA can be calculated with three within-subjects factors and there is a main effect of waist, length and hem on coincidence percentage.

Figure 8 shows the interaction effect of waist and hem. There is a significant interaction between waist and hem according to the analysis ($F = 1.982$, $p = 0.033<0.05$) and the interaction indicates that silhouette elements of waist and hem were not only important but also interdependent when subjects judge the fashion of female suits. Moreover, there is also an interaction effect among waist, length and hem when subjects make the decision whether female suit is fashionable ($F = 1.328$, $p = 0.021<0.05$).

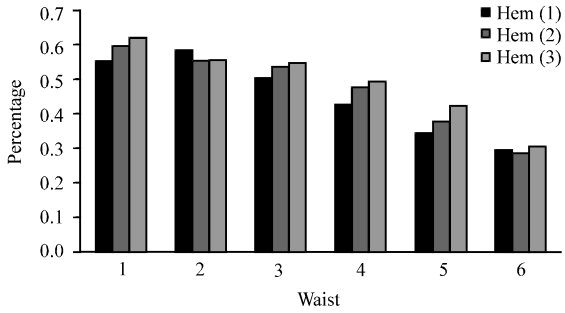

Fig.8: Interaction effect of waist and hem

Table 1: Interaction effect of hem and waist

	Waist (level)	F	p-value
Hem	1	4.78	0.01
	4	4.34	0.015
	5	4.81	0.01

Table 2: Interaction effect of hem and waist on length level

	Length	F	p-value
Interaction waist×Hem	1	1.217	0.276
	2	2.615	0.004
	3	1.525	0.126
	4	0.983	0.457
	5	0.732	0.695
	6	1.987	0.032
	7	1.064	0.388
	8	1.71	0.075
	9	0.885	0.547
	10	1.491	0.138

Table 3: Effect of hem on waist level and length level

	Waist (level)	Length (level)	F	p<0.05
Hem	1	2	5.04	0.008
	2	6	3.25	0.042
	3	6	5.81	0.004
	4	4	3.13	0.047

In order to further discuss the data in different levels, Simple Main Effect (SME) test is done. It can be drawn from the test that the effect of waist on people's judgment for the fashion of female suits differs significantly in each level of hem, while effect of hem only differs in level 1, level 4 and level 5 of waist, as shown in Table 1. Consequently, only matched with particular waist size will hem produce fashionable emotion for subjects.

Distribution of interaction between waist and hem is on length level, as shown in Table 2. In each level of waist and hem, the effect of length is significant. Similarly, in each level of length and waist, the effect of waist is significant, whereas the effect of hem differs significantly in few levels of waist and length. As Table 3 shows, for the three silhouette elements, the effect of hem is less essential than that of waist or length.

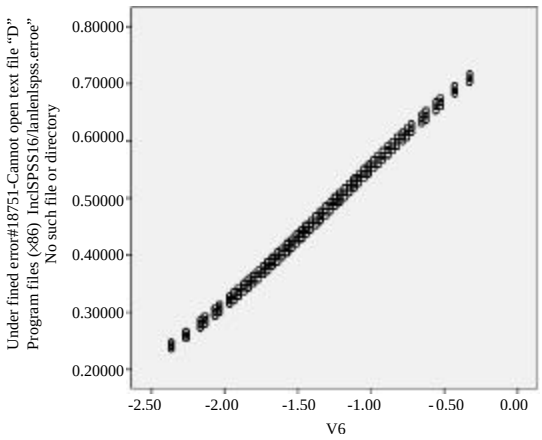

Fig.9: Scatter graph of logistic regression

Table 4: Coincidence percentages based on hem level

Waist (level) Length(level)	Hem(1)	Hem(2)	Hem(3)
W(1)L(2)	40.63%	51.56%	62.50%
W(2)L(6)	64.06%	67.19%	59.38%
W(3)L(6)	45.31%	53.13%	62.50%
W(4)L(4)	53.13%	56.25%	53.13%

The fashionable degree of female suit silhouette is shown in Table 4. Silhouette of female suit is fashion with hem opening level 2 and 3 but the degree is not deep.

Regression analysis: In order to testify which silhouette element was most important to play a decisive role in people evaluating female suit as fashion or not fashion, Chi Square test was done to the data. Based on the importance of silhouette element, waist and length was chosen in regression analysis. Under every level of waist, effect of length affecting people in evaluating female suit fashionable differed significantly. At same time, under every level of length, effect of waist affecting people in evaluating female suit fashionable differed significantly. Interaction effect was significant between waist and length. Under every level of waist and length, effect of hem affecting people in evaluating female suit fashionable differed not significantly. So, silhouette element of waist and length play decisive role in people evaluating female suit fashion or not fashion.

For further information, Logistic Regression was done to the data. Equation 1 was probability function of people evaluating female suit fashionable. The regression trend is shown in Fig. 9.

$$Pyes = 1/(1+EXP(-0.229*W-0.099*L)) \quad (1)$$

W-waist , L-length, yes-people evaluating female suit fashionable.

CONCLUSIONS

In summary, silhouette elements of waist, length and hem opening can be considered as characteristic elements in cognition of female suit silhouettes and the effect of each element on people's judgment on the fashion of female suit silhouettes is studied. Each element can be considered alone but hem opening should be matched with appropriate length or waist in female suit designs, as its effect of making people judge the suits to be fashionable is not significant in every level of waist and length. Combined with the past research about the effect of waist, length and hem on subjects judging female suit silhouette to be professional and favorite, styles can be analyzed by some emotional words including "professional", "favorite" and "fashionable". By comparing the effect of different representative words, how silhouette elements affect style of female suits will be achieved and the results can be modeled and put into software by computer to achieve new designs.

Because female suit in this study are based on practical measurement and real clothing structures, if the maximum and minimum measurements are determined (only for ready-to-wear clothing, not for exaggerated fashion design), silhouette of female suit in fashion trend will be shown. The behavior results of subjects can be the basis of sensory cognitive evaluation system and other silhouette elements parrying sensory words in style system will be discussed with the research going on.

Furthermore, reaction time that subjects respond to make a decision in evaluating female suit fashion will be measured in further research and the results will provide the theoretical and cognitive basis for evaluation or computer simulation system in fashion designs.

ACKNWLEDGEMENT

This study is funded by the First Phase of Jiangsu Universities' Distinctive Discipline Development Program for Textile Science and Engineering of Soochow University.

REFERENCES

Anderson, J.R., 2009. Cognitive Psychology and Its Implications. 7th Edn., Worth Publishers, USA., ISBN: 9781429280525.

Auer, P., A. Billard, H. Bischof, I. Bloch and P. Boettcher *et al*., 2005. A research roadmap of cognitive vision. ECVision: European Network for Research in Cognitive Vision Systems. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.154.721&rep=rep1&type=pdf

Baek, S., M. Hwang, H. Chung and P. Kim, 2008. Kansei factor space classified by information for Kansei image modeling. Applied Math. Comput., 205: 874-882.

Granlund, G.H., 1999. Does vision inevitably have to be active? Proceedings of the Scandinavian Conference on Image Analysis, Volume 1, June 7-11, 1999, Kangerlussuaq, Greenland, pp: 11-20.

Jiang, X. and G. Liu, 2009. The influence of color brightness on the perception of clothes gorgeousness. Proceedings of the IEEE 10th International Conference on Computer-Aided Industrial Design and Conceptual Design, November 26-29, 2009, Wenzhou, China, pp: 1273-1276.

Nagamachi, M., 2002. Kansei engineering as a powerful consumer-oriented technology for product development. Applied Ergon., 33: 289-294.

Qin, F., S.S. Wang, X.F. Jiang and G.L. Liu, 2009. Study on influences of collar types towards women?s T-shirt fashionable design based on visual cognition. Proceedings of the IEEE 10th International Conference on Computer-Aided Industrial Design and Conceptual Design, November 26-29, 2009, Wenzhou, China, pp: 1579-1583.

Su, J.Q. and G.L. Liu, 2009. Techniques of efficient 3D human body modeling and feature measurements extraction based on reverse engineering. Proceedings of the World Congress on Bioengineering, July 26-29, 2009, Hong Kong, China, pp: 645-648.

Vernon, D., 2006. The Space of Cognitive Vision. In: Cognitive Vision Systems: Sampling the Spectrum of Approaches, Christensen, H.I. and H.H. Nagel (Eds.). Springer, Berlin, Germany, pp: 7-24.