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# Application of ERPs to Evaluation of Clothing Comfort through physiological signals

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***Abstract***

*Based on analyzing domestic and foreign literatures concerning event-related potential research, this paper analyses the theory of comfort of wearing by using ERPs. This paper makes a summary of what comfort evaluation for wearing using ERPs, Finally propose the research direction in this domain of identifying from EEG the nerve reflection related to special feeling and neurocognitive events, for the purpose of using impersonal metrics to evaluate subjective feelings of clothing comfort and then provide a new method for designing clothing to be more comfortable.*

***Key words:*** *event-related potential; EEG; comfort of wearing, clothing*



## 1. Introduction

With human society developing to this day, the need for the clothing has already exceeded the traditional need of covering and warming, and more emphasized wearing comfort and visual aesthetics, etc. So the clothing comfort becomes a focus of the modern consumers on apparel products domestic and foreign researchers also are applying the new theories, new methods in this field, which is becoming the research hotspot of clothing disciplinary.

Clothing is a form of communication for expressing human individuality, emotion, status, social position, and information surrounding their circumstances. The function of expressing emotions of clothing is associated with a corresponding aesthetic process and psychological process arising from objective things and human's needs, including experiences (such as the subjective feeling about happiness, sadness or hate), physiological action (such as the neural activity of cortex, peripheral and central nervous system changes, etc.) and expression (such as facial expressions, posture, movement, etc). Therefore, well-designed clothing should not only satisfy requirements, but should also satisfy consumers' psychological needs, such as emotional needs [1]. Different clothing styling could evoke consumer's positive (interest, pleasure) or negative (disgust, unpleasure) responses. These responses refer to the brain activities in particular situations. Emotional stimuli evoked scalp-recorded brain potentials. Explored and analysis these emotions could help us to understand human perception, cognition, affect and formulate design decision-making by empirical research.

With the continuous improvement of fashion design system, there are several researchers paid their attention to the emotional responses about color, pressure, comfort and tactile aspects in clothing field via using physiological instrumentation. For example, Yoko et al had used the semantic differential method and electroencephalograph measured the brain waves to examine the different color of wearing image through an experiment using two kinds of one-piece dresses [2]. Horiba et al proposed an evaluation method of tactile sensation by using physiological response for the purpose of evaluating tactile sensation objectively through measured P300 in event related potential (ERPs), and studied the relation between P300 and tactile sensation, confirmed availability of P300 as an index of evaluating tactile sensation [3]. Miyatsuji et al had designed to investigate the effects of clothing skin pressures exerted by two different types of brassieres (a conventional higher skin-pressured brassiere and a newly devised low skin-pressured brassiere) on the autonomic nervous system (ANS) activities [4].

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Based on this situation, the present paper concentrated on using a direct communication pathway between the maid-brain and an external device to quantitatively describe the emotions evoked by clothing styling, and associated with brain-computer science and psychophysiology to assess the emotional responses of the sportswear from the males and females viewers. The main purpose of this research was to use brain imaging technology to recognize the differences of "inner" emotions between males and females from brain wave signals, and to examine the interactions of human's psychological emotion dimensions and psycho physiological responses by compared the emotional dimension of self-reported results with real-time brain wave data. This research detected emotional cues occurring during event-related potentials (ERPs) techniques. ERPs are a non-invasive method of measuring brain activity during cognitive processing, and could provide extremely high time resolution, in the range of one millisecond [5-7]. The advantage of this technique is that they are able to directly access the primary response to an emotional stimulus (revealed in the brain activity). It is a new method for fashion design that related the brain science research methods to the quantitative study of clothing visual emotion.

## 2. Method

### 2.1. Subjects

Twenty healthy college students (10 males, 10 females) aged 19-23 years (mean: 20.2) from different majors (e.g., design, finance, psychology, marketing, management, electronic, etc) of Minjiang University participated this study. All subjects were asked to abstain from drinking, eating, smoking, exercise for at least three hours before the experiment, and keep good rests.

### 2.2. Stimulus

The stimuli were 15 different uniforms of Minjiang University. To ensure the comparability, the basic styling was 165/84XL sportswear with cotton/polyester fabric, long-sleeved coat with zipper in the front and straight sports pants. Taken the front photograph by one model whose height was 165cm and worn white shoes. Set the brightness, contrast, pixel size and other attributes of stimulus pictures to the same value using Photoshop CS (Adobe). Each picture was numbered 1-15 and resized to fit 800 pixel×1200 pixel frame and saved as bmp file.

### 2.3. Procedure

#### 2.3.1. Psychological Responses Measure

The present experiment used Self-Assessment Manikin (SAM) rating system devised by Lang (1980) to assess the psychological responses of emotions from the aspect of pleasure, arousal, and dominance [8]. Nine-point rating scale were used for each dimension. Rating was scored such that 9 represented a high rating on each dimension (e.g., high pleasure, high arousal, high dominance), and 1 represented a low rating on each dimension (e.g., low pleasure, low arousal, low dominance), 5 represented the center segment of the scale. Explained the definition of pleasure, arousal, and dominance to the subjects before the experiment and make sure they fully understood the concept and evaluation criteria for each assessment. Each subject viewed the pictures one by one and assessed the scores. This experiment emphasized the first feeling of themselves. There was no right or wrong answers.

#### 2.3.2. Physiological Responses Measure

Physiological responses mainly measured the real-time brainwaves of each subject using EEG/ERP recording and analysis system of Neuroscan company on a dedicated recording computer. The stimuli presented through another dedicated stimulating computer with E-prime software for time and stimuli control.

Each picture was perceptually random within a sequence, lasted 2000ms and occurred 10times. Each stimulus made mark in E-prime software, and then sent synchronization makers directly to the recording computer (Figure 1). The subjects did not judge their emotional reactions while viewing the pictures, just concentrated on each picture.

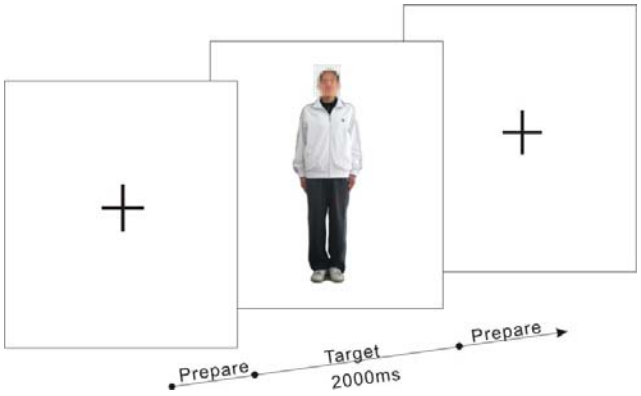


Figure 1. Schematic of the Experimental Paradigm used

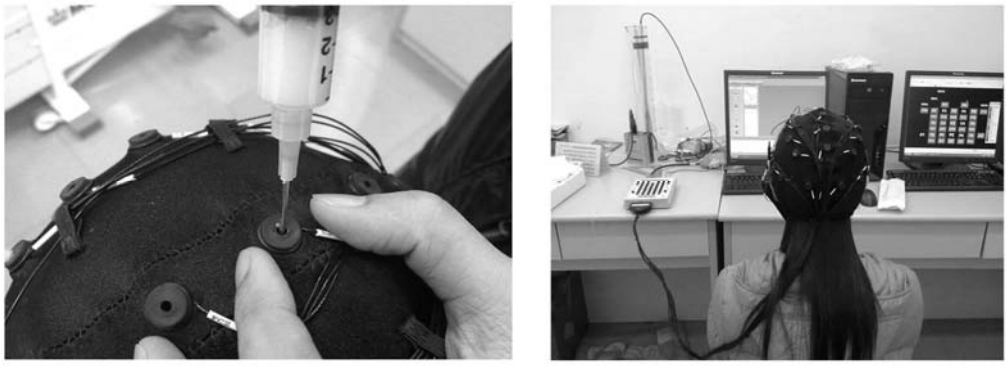

Figure 2. A Participant Shortly Before the Experiment

The amplifier collected the stimulating codes and brainwaves at the same time. ERPs were recorded using an electrode cap from nine key sites (F3, Fz, F4, C3, Cz, C4, P3, Pz, P4) according to the International 10-20 Electrode system. All channels were recorded use both mastoids (A1, A2) as a reference electrode and Gnd channel as a ground electrode. Vertical and horizontal eye movements (VEOG, VHOG) were recorded also. All electrodes impedances were maintained below 5 kΩ. DC mode sample data, sample rate was 1000Hz/channel, high pass was 0Hz, low pass was 100Hz. Figure 2 showed a participant shortly before the start of the experiment.

### 2.4. Date Analysis

Mean factor scores for each picture (averaged all subjects) on each of the factors of pleasure, arousal and dominance were calculated using statistics analysis. Off-line analysis of the recorded brainwaves data used Scan 4.3 software. The analysis course began 100ms before onset of stimuli, and continued until 1900ms after the onset of the stimuli. Set 20 blinks of vertical EOG and each blink continued 400ms and horizontal EOG continued 800ms to remove the electric current of eye's activities in the experiment. Following eye movement correction procedure, corrected baseline and rejected artifact. Then, averaged and flitted ERPs waveforms separately for each valence category and electrode site; and at last, averaged the ERPs waveforms of all subjects (Figure 3).

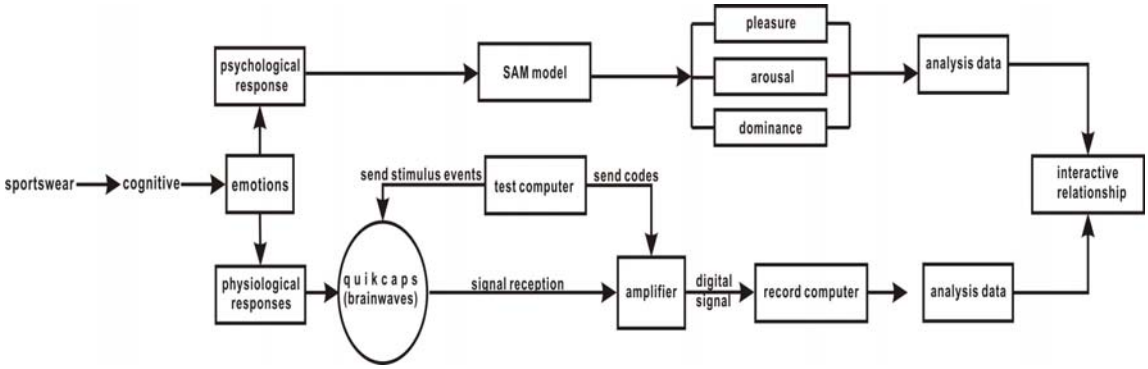


Figure 3. Illustration of Measure Procedure

## 3. Results

### 3.1. Descriptive Statistics Analysis of Psychological Responses

The data of descriptive statistics analysis for pleasure, arousal and dominance are present in figure 4 use line chart. After average each dimension value of all male subjects and female subjects, it is shown that the relationship between pleasure and arousal presents two kinds of trends. One showed pleasant and arousal presented positive correlation, the other showed negative correlation. But pleasant and dominance were positive correlation. When the value of pleasure was high, the value of dominance was high also. Oppositely, the value of pleasure was low with the decrease of dominance. The standard deviation of these two dimensions were approximated.

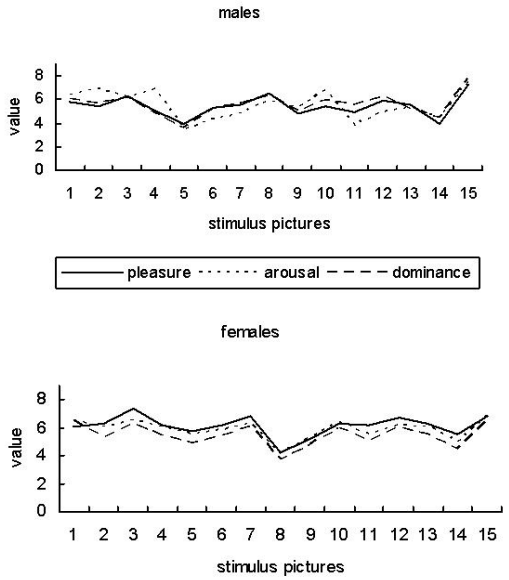


Figure 4. Line Chart of SAM Model Assessment

In addition, for males, No.5 & No.14 had the lowest arousal and dominance, No.15 had the highest pleasure, meanwhile, following the highest arousal and dominance, it demonstrated that this styling had higher wearing and consuming desire. And for females, No.8 had the lowest pleasure, arousal and dominance, No.3 & No.15 had the highest three dimension, It demonstrated that this styling had higher wearing and consuming desire. It indicated that males and females had similarity and inconsistency for the emotional response of different styling of clothing.

### 3.2 ERPs Data Analysis of Physiological Responses

Based on SAM results, we choosed the styling with the highest value in SAM model(No.15) and one of the lowest value(No.8) of Fz, Cz, and Pz to do ERPs data analysis. Used Scan4.3 software to average the brainwave data of all subjects (Figure 5). The amplitude and latency of ERPs components provide information regarding the strength and time course of underlying neural processes [7]. For pleasure and arousal, the largest change of brainwave was observed at Fz (Frontal), intermediate at Cz (Central), and the least at Pz (Parietal). For all area measures, different pleasure and arousal influenced amplitudes from 150ms after different styling appearance. The styling with the highest value in SAM model presented last slow potentials (LSP) from 150ms to the end of stimulate in forehead area, and correlating with its high pleasure and arousal. LSP is followed by an extended positive slow wave associated with the processing of emotional pictures. Different pleasure and arousal presented different going of amplitude from 650ms in the middle of brain. Lower value in SAM model presented a early negative peak at 100ms and subsequent negative going lasted to the end of stimuli.

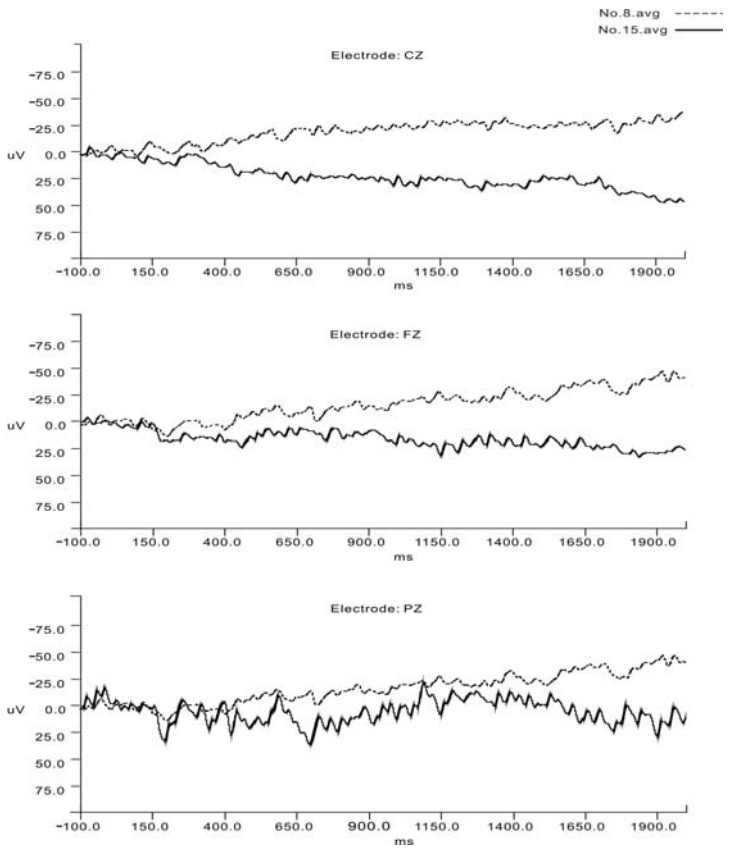


Figure 5. Grand Average ERPs at Fz, Cz and Pz for All Subjects

## 4. Discuss

### 4.1. Psychological Responses of Emotion

The value of dominance getting higher following the value of pleasure was high. Oppositely, the value of pleasure was low with the decrease of dominance. It is demonstrated that emotion dimensions showed positive correlation between pleasant and dominance evoked by clothing styling. Therefore, the pleasure of emotion could be as an index of evaluate consume desire.

### 4.2. Physiological Responses of Emotion

Pleasure stimulating factors primarily modulated ERPs component amplitudes, with little changes in peak latency observed. Arousal effects were consistently obtained, and generally

occured at longer latencies. Valence effects were inconsistently reported at several latency ranges, including very early components. That means amplitudes reflected the excited extent of brain, latent periods reflected the speed and time of emotional activity and process.

### 4.3. The Relationship between Psychological and Physiological Responses

The changes of three dimensions were basically consistency with the ERPs amplitudes. Higher pleasant and arousal reflected the higher excited extent of brain, and the bigger amplitude of ERPs in the middle of forehead area. Therefore, self-assessment could provide effectively reference for physiological measurement of emotion.

### 4.4. Styling Analysis of Clothing

It was showed that males and females had similarity and inconsistency for the emotional response of different clothing styling from the experimental analysis. They all pay more attention on No. 15 which had simple styling with light-colored, and looks neatly, comfortably and youthfully. Furthermore, the male students were inclined to green and linear decoration. For female college students, they paid more attention on the styling which had the color of red match white, green match white, and focus on simple styling [9-15].

## 5. Conclusion

Based on the present study, we demonstrated that visual evoked emotion with clothing styling could be measured through combine the interactive relationship between self-assessment and real-time brain potentials data. The research proposed a new scientific research method of clothing field, and provided scientific guidance for future trend and development of fashion design.

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