The Possibility of objectively evaluating how fashion affects the human body

Keywords: objective evaluation / physiological influence / hormone activity

Abstract

It is obvious that fashion brings pleasure to people and stimulates human relations. Designers and researchers are interested in objective judgments which measure quantitatively how fashion affects people. It is difficult, however, to measure the effects of fashion on the human body. In general, subjective judgment of one's impression of fashion is expressed by means of words. However, methods which objectively measure the effects of stimulation on the physiological activity of the human body have been developed.

In this paper, we present research concerning how various clothing qualities influence the human body and propose an objective way of evaluating how fashion affects the physiological activity of the body. Furthermore, we will attempt to measure the effects that wearing clothes or looking at fashionable clothes have on autonomic nervous activity and the endocrine system of the human body. It is clear that such methods are useful for making objective judgments of the physiological influences of fashion on the human body. It is believed that if such objective evaluation methods continue to develop, through such new techniques as wearable computers, we will be able to know how people " feel" about fashion. This will enable us to propose new creative fashions with more confidence.

Introduction

It is obvious that fashion brings pleasure to people and stimulates human relations. Designers, companies and researchers are interested in objective judgments which measure quantitatively how fashion affects people or the degree to which different fashions bring pleasure to people.

It is difficult, however, to measure the effects of fashion on the human body.

It is believed that if such objective evaluation methods continue to develop, through such new techniques as wearable computers, we will be able to know how people " feel" about fashion. This will enable us to propose new creative fashions with more confidence. In this paper, we will introduce some scientific measuring methods along with previous research on the influence that outside stimuli have on the human body.

Objective Observations

Various stimuli which act on the human body are received by sensory organs, such as the eyes, ears and skin, and transmitted to the brain through peripheral nerves. Such stimuli are received and integrated in the brain. After that, acceleration or inhibitory instructions are transmitted to the organs, which allow the autonomic nervous system and the endocrine system to maintain a suitable condition for the body. In this way, the human body is maintained constantly.

There are three methods used to measure the effects of stimuli on the human body. First, we can measure the activity of the central nervous system before mental or behavioral responses to stimuli occur. Second, we can measure the activity level of the sympathetic and parasympathetic nervous systems which are responsible for transmitting instructions from the brain to each organ. Third, we can measure hormone secretion from the endocrinal system in the blood, saliva and urine.

Nerve activity is an electrical phenomenon. Therefore, when we measure changes in the central or autonomic nervous activity, a physical response technique is used. On the other hand, a chemical response method is used for measuring endocrine activity. These subjective indexes are reliable because they are determined by evaluating changes within individuals.

Methods of measuring central nervous system activity

EEG (electroencephalogram) measurement has been used in order to measure brain activity, but recently, progressive diagnostic imaging techniques such as functional MRI(magnetic resonance imaging) and NIRS(near –infrared spectroscopy) are attracting a growing interest and are being applied to psychological study. However, EEG frequency spectrum analysis is commonly used to study the condition of the human body by observing how different stimuli arouse different parts of the brain.

Methods of measuring automatic nervous system activity

As opposed to using a direct form of measurement, the reaction of internal organs controlled by the autonomic nerve system is used to measure the activity of autonomic nerves. Because the fluctuation of the heart rate decreases when it blocks the parasympathetic nervous activity, heart rate interval analysis is used as a stress index. When the human body is stimulated by stress-inducing activities, such as heavy exercise or mental activity, the sympathetic nervous activity increases. Recently, a portable monitoring system using software that performs frequency analysis has been developed.

Methods of measuring endocrine and hormone secretion activity

To understand the relationship between stimuli to the human body by mental or physical stress, chemical substances called “biomarkers” in samples of blood, saliva and urine were assayed. The variation of the concentration of that biomarker by different types of stress is already known. For example, we know that a high concentration of cortisol is an index of activity of the endocrine system, and immunoglobulin A and natural killer cells are an index of activity of the immune system. Recently, equipment for measuring the concentration of amylase as a way of gauging activity in the sympathetic nervous system has been developed and it shows that negative stimuli increase amylase activity.

The influence of color on the human body

Color is an important influence on fashion and its power heightens the value of fashion in human consciousness. It is important in many research fields - in addition to fashion - and for this reason a vast amount of research has been accumulated. Until now, subjective evaluation has been used to measure the effect of color.

We (2004) conducted an experiment to clarify the effect of color on human performance. We observed the relationship between tennis wear and tennis playing. The color of sportswear has a psychological effect on players themselves, a visual effect on opponents and an effect on referees and spectators.

The visual effect that players’ clothes have on their opponents is particularly striking, since tennis players need to react very quickly to their opponents’ actions.

Firstly we measured the EEG of three females (20-22 years old) who viewed nine color sheets: red, reddish purple, yellow, navy-blue, black, green, purple, orange and white.

The subjects looked at each sheet for one minute. EEG measurements were taken by a digital multi SYNAFIT5000 (NEC Corp.). The measurements were recorded from seven electrodes and the spectral power of the continuous EEG in each period was obtained by First Fourier Transform. The frequency range was separated into α（8-13Hz）, β(13-40Hz), θ(4-8Hz) and δ(0.5-4Hz).

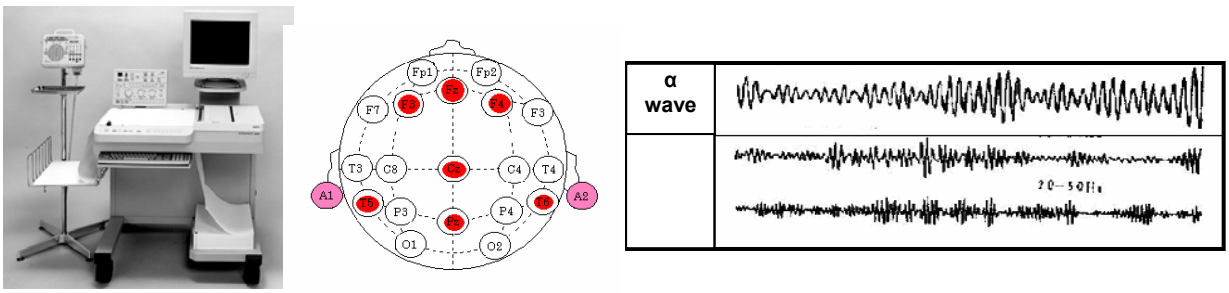

Fig.1 EEG measurement

It is known that a high component of β wave indicates that a person feels high stress and has a high arousal level. In contrast, α waves increase when a person feels relaxed. The results of our study show that there was a high component of α wave when the subjects looked at the black sheet and a low component when they looked at the white sheet. In addition, the component of α wave tended to increase when the subjects looked at their favorite colored sheet. The component of β waves was highest when the subjects looked at the white sheet, followed in descending order by the reddish purple sheet, the dark blue sheet and the purple sheet. It shows that white makes people unconsciously tense up, while black causes a low level of arousal.

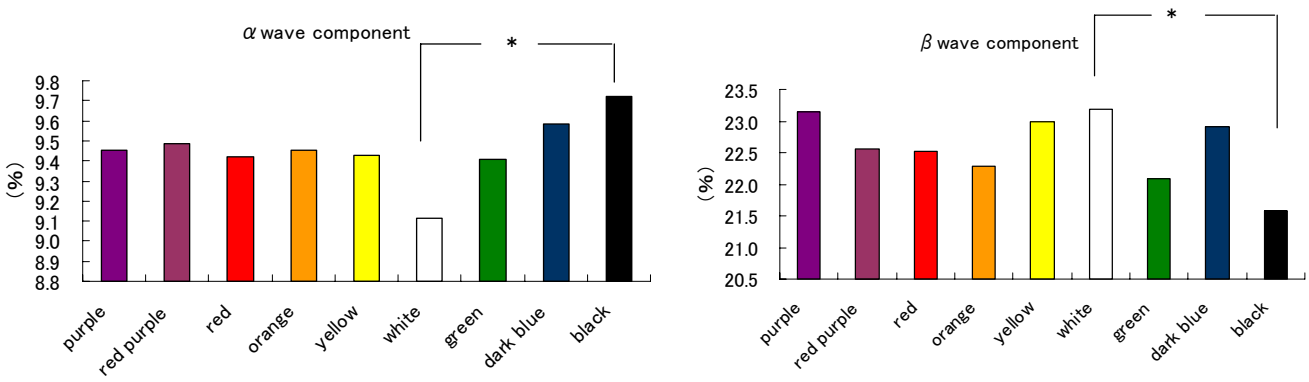

Fig.2 The component of α waves and β wave

We then measured the agility of the subjects who were told to jump sideways when a certain colored sheet was shown. One of two same-colored sheets were positioned side by side was raised when the test researcher said “now.” The subject was instructed to jump to the same side as the raised color when one of the sheets was raised and to clap once as quickly as possible. The results showed that the subjects could react more quickly when the orange and white color sheets were raised. It took them longer to recognize the black sheet. It seems that black has a lower level of visibility, while orange has a high level of visibility.

Fig.3 The agility test scene and the result of reaction time measurements

Furthermore, some skilled tennis players wore clothing to which a color sheet was attached to the chest area when they played tennis. The number of times that the ball was successfully returned was measured as a percentage. The results showed a higher return percentage when the ball was returned to a player wearing white and orange, while lower percentages were recorded for black and reddish purple. These results show that it is easy to notice the opponents' actions when they wear orange or white uniforms. If the players wear those colors themselves, they are easily noticed by their opponents. On the other hand, if players wear black or reddish purple uniforms, it appears to be harder to read their actions by opposing players.However, it also seems that the uniform color affects the wearer's brain activity. Actually, if players wear their favorite colored uniforms, they display higher motivation and react more quickly.

It seems that the color of their uniforms affects them both mentally and physically. However, it appears that color preference is more a result of human experience than the influence of colors themselves. The psychological effect of colors requires more research and discussion.

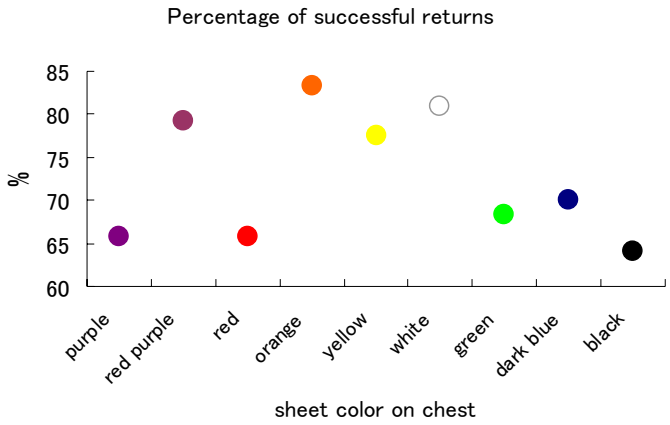

Fig.4 The percentage of successful returns

The relationship between a comfortable touch sensation and autonomic nervous system activity

We wear clothes all day, so it seems that the tactile sensation from fabric affects the human body condition. We (2001) measured heart rate variability of seven young female students (19-22 years old) who wore dresses made of rough, hard fabric and soft, smooth fabric. An ECG (electrocardiogram) was taken with the POLYGRAPH System (Nihon Kohden Corp). We calculated the power spectrum of the ECG by frequency analysis. LF/HF (LF (Low-frequency spectral power (0.04－0.15Hz) / HF (High-frequency spectral power (0.15-0.4Hz)) was used as an index of cardiac sympathetic nervous system activity and HF/(LF+HF) was used as an index of cardiac parasympathetic nervous system activity. The results showed

that LF/HF decreased significantly and HF/(LF+HF) increased in the case of wearing a soft, smooth dress.
Conversely, Watanuki et al.(1998) measured the effects of tactile stimulations of rough underwear and soft underwear on autonomic nervous activity in seven females (21-23 years old). Research showed that rough tactile stimulation may depress both parasympathetic and sympathetic activities.

The relationship between clothing presser and autonomic nervous system activity

The relationship between fashion and clothing pressure has long been known and the effect of pressure applied to specific parts of the human body has been studied extensively. Heavy clothes and the movement of body joints cause clothing pressure. Recently, the popularity of stretch fabric has caused a problem concerning the tightness of clothing, called “hoop tension.”
Today, there is interest in how clothing pressure affects one’s emotions as well as its effectiveness in making a slimmer figure. Thus, frequent attempts have been made to evaluate subjectively the effect of pressure, in addition to objective evaluations. Such evaluations are applied to sportswear and clothing for rehabilitation, and, more recently, the evaluation of the effect of pressure on fashionable wear.

We (2006) studied the effects of clothing pressure on the human body. Heart rate variability of ten female subjects (21-24 years old) was examined when the clothing pressure was applied with a non-stretch 3 cm-wide belt to the subject around the breasts, waist and hips. The clothing pressure under the belt was 30hPa, so the subjects felt a slight tightness. The results suggested that clothing pressure around the lower body applied by stretch garments, such as a girdle or sport spats, increases the blood pressure in the upper body, which affects the autonomic nervous system, particularly the activity level of the parasympathetic nervous system.

On the other hand, we (1999) measured the heart rate variability and EEG of the subjects who wore two types of sportswear. They were different in terms of ease of wear. One was a tight, high-pressure suit and the other was a loose-fitting, no-pressure suit which was loose around the underarms, body and legs. The subjects were lying or sitting at rest and exercising using an ergometer. As a result, it was shown that the sympathetic nervous activity of pressure suits increased and parasympathetic nervous activity decreased.
These results and results from our previous experiments showed the presence of high pressure at the waist. It seems that different pressure strength, extension and location have different effects. Furthermore, EEG analysis did not show that the difference was significant

between high pressure suits and non-pressure suits. However, there is a tendency for the amplitude of α waves to decrease when the subjects wear high-pressure suits.

It would be interesting to find out if the clothing pressure and the consciousness level of humans can be controlled. Also, further research regarding the effects of behavioral changes observed when wearing fashionable clothes and casual, relaxing clothes promises to be an exciting challenge field of study for both researchers and designers.

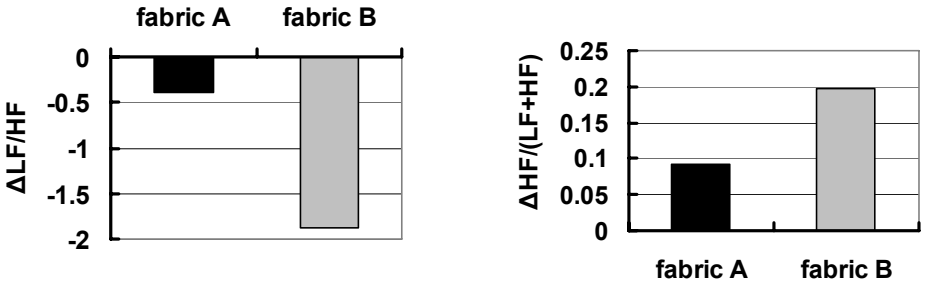

Fig.5 The activity level of sympathetic and parasympathetic nerves

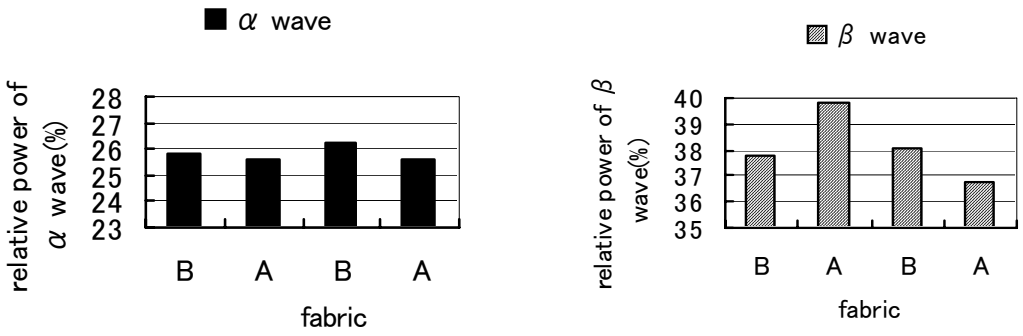

Fig.6 Comparison of EEG relative power of α wave and β wave

Measuring the effect of fashion clothing on autonomic nervous system activity

There is a study that measures the effect of fashion on the human body more directly. We (2002) conducted experiments to quantify the effect of the desire to dress fashionably on the autonomic nervous system. Eighteen female subjects, aged 21 to 23, wore three types of clothes. The first was everyday wear, the second was their favorite clothes and the third was clothing which they did not like. The subjects sat in front of a mirror and gazed at their figures. An ECG (electrocardiogram) was taken and heart rate variability was analyzed using Bital Rhythm 98 (NEC Medical Corp).

The results showed that the LF/HF didn't change when the subjects evaluated the figures of themselves wearing everyday wear. But LF/ HF increased significantly when the subjects

wore their favorite dresses and clothes they disliked. ($p<0.05$). It appears that the sympathetic nervous activity was stimulated more when they wore their favorite outfits.
Research also shows that clothing preferences and comfortability affect human brain activity. The result is variable because of the emotions generated by clothing controlled the activity of the autonomic nervous system.

And the fact that wearing one's favorite clothes activates the activity of the sympathetic nervous system showed that the desire of dressing comfortably and stylishly is an essential and basic desire for humans. This result is important, as the experiment clarified the effectiveness of heart rate variability measurements for "The Possibility of Objectively Evaluating How Fashion Affects the Human Body", which is the title of this presentation.

The evaluation of the effect of clothing on the human body using hormone analysis

Since Sugimoto showed the influence of clothing pressure of the foundation garments on the hormone level in urine of the subject (1991), hormone analysis has been tried by some researchers in Japan to determine the effect of clothes on the human body. Watanuki (1995) showed a significant effect of the softness of children's underwear on the secretion of IgA (s-IgA), while Kioka et al. (2003) examined the effect of softness of sleep wear fabric on the secretion of catecholamine and melatonin in the urine and concluded that there was no effect on the secretion of the hormones over a seven-day period. Mori et al. (2005) examined the stress levels of women wearing fashionable high-heeled shoes by measuring the concentration of cortisol in saliva, and found that the concentration of cortisol was significantly higher when the subjects wore high-heeled shoes.

We (2001) studied the endocrinological effect of two different humidity conditions on the salivary and urinary hormone levels. Twelve healthy female subjects (21 to 22 years old) were exposed for 90 minutes in a variable condition of 30 to 70% RH at 34℃ and then constant condition of 30% RH at 34℃. The body weight loss, heart rate variability , salivary cortisol concentration, s-IgA in saliva, and urinary catecholamine fraction were measured. Saliva was collected for 5 minutes. The collected saliva was frozen, and the samples were transported to SRL, Inc., for analysis of salivary cortisol and immunoglobin A. The results showed that the subjects who sweated a lot in the increasing humidity condition secreted increased amounts of s-IgA and noradrenaline. It showed that the human discomfort condition by stress influenced the secretion of hormones.
And it was shown that the index of sympathetic nervous activity obtained from HRV (heart rate variability) changed in relation to the sweating rate of the subjects. Therefore, it can be

concluded that hormone analysis is useful for the evaluation of the effect of stress on the human body using HRV measurement concurrently.

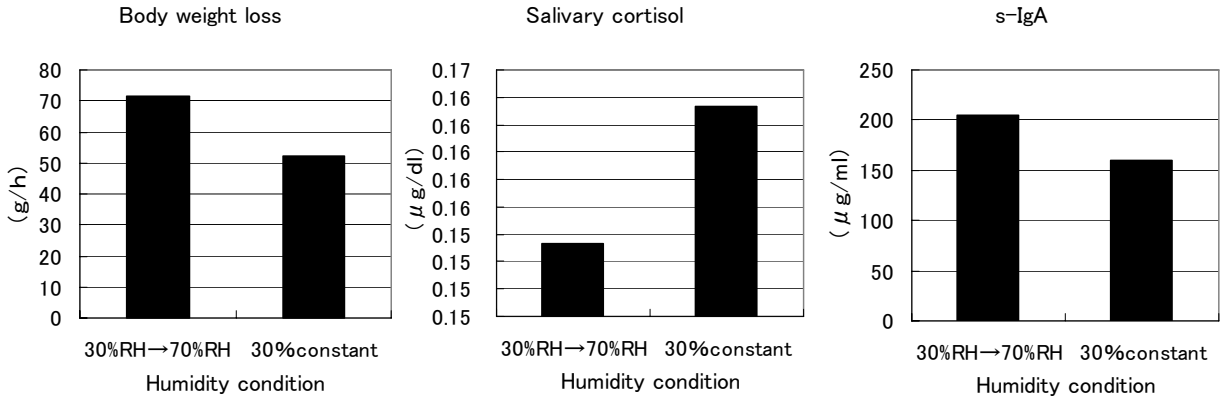

Fig.7 Body weight loss and salivary cortisol and s-IgA

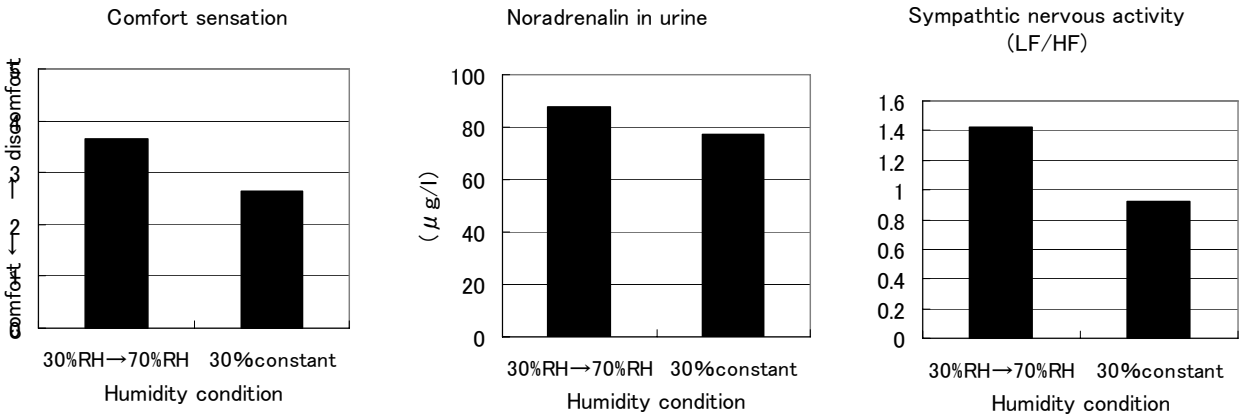

Fig.8 Comfort sensation, noradrenalin in urine and sympathetic nervous activity

Favorite fashionable clothes

Disliked unfashionable clothes

Fig.9 Experiments in progress

Next, we are going to clarify the effects of fashionable and unfashionable clothes on the hormone concentration in saliva and the autonomic nervous system. The subject is required to look at herself in a mirror while at the same time being looked at by another person, also looking at the mirror. The subject wears her favorite fashionable clothes for the first ten minutes, then disliked and unfashionable clothes for next the ten minutes. During the experimental period, the α-amylase in the saliva as a stress hormone and measurement of s-IgA concentration, and frequency analysis of heart beat rate variability are measured. The subjects consist of nine healthy female students (21-22 years old).

The results showed that α-amylase and s-IgA concentration in saliva increased in eight subjects when changed from their favorite fashionable clothes to the unfashionable outfits. Activity of α-amylase was controlled by the sympathetic nervous system. This showed the similarity change with the change of the LF/HF ratio, which increased remarkably when the subjects wore clothes they disliked. Salivary s-IgA, which works in the biological defense system, showed a similar change; therefore these data suggest that α-amylase and s-IgA in saliva are bio-makers of stress. This suggests that the stress of the subjects decreased when they wore clothes they liked. The stress increased when they wore unfashionable clothes and were looked at by another person. It also suggests that the stress level can be evaluated by analyzing the hormone concentration in saliva.

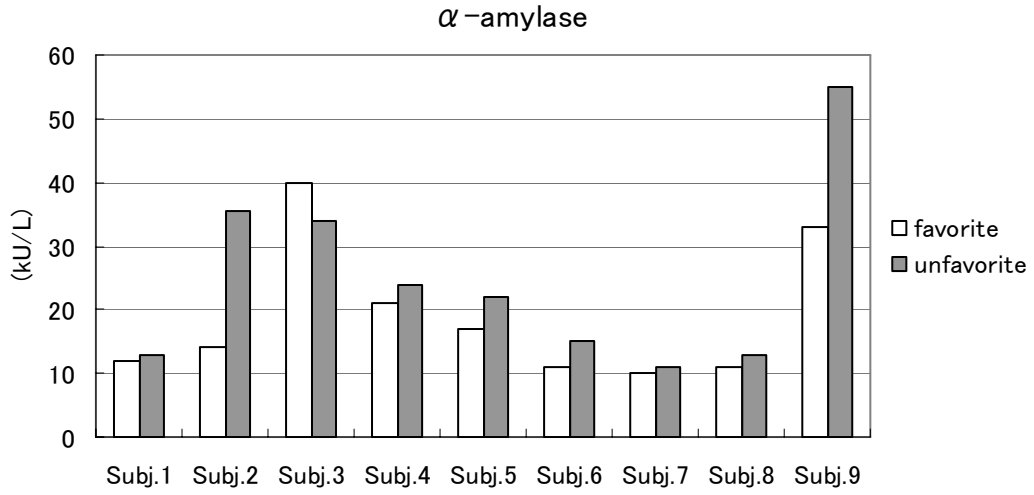

Fig.10 The activity of salivary α-amylase

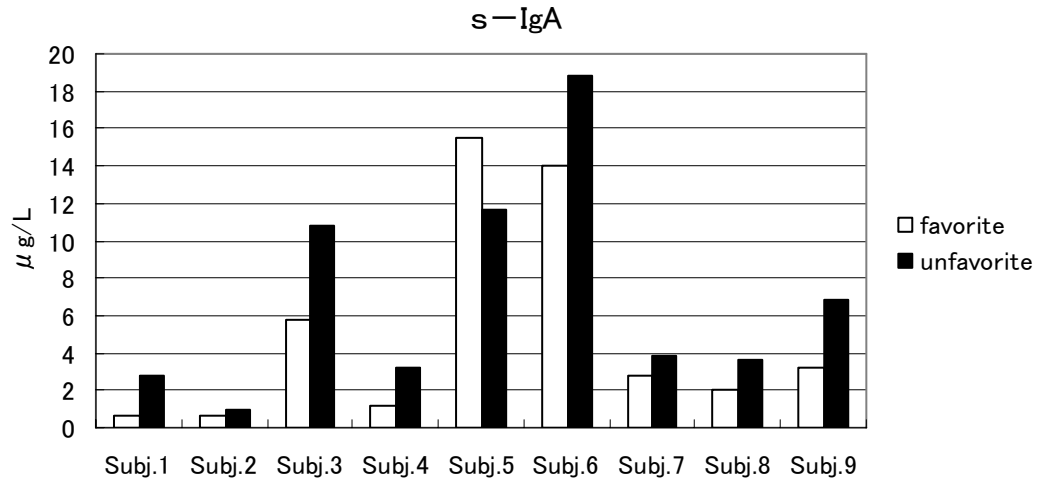

Fig.11 The concentration of s-IgA

Conclusion

Until recently, evaluation of the effects of clothing on the wearer has been primarily subjective. But now we have demonstrated methods which objectively measure the physiological effects of fashion, by using data derived from heartrates, brainwaves and hormones.

One area where this is particularly useful will be with people who, for reasons of age, health or language ability, cannot provide subjective comments. Examples would be people in nursing homes, young children and even people who cannot speak Japanese.

Results of recent experiments conducted at nursing homes have shown that wearing clothes which make the resident feel comfortable, or “fashionable,” have a beneficial effect on their health. And another interesting finding is that even the clothes worn by the staff has an effect on the health and well-being of the residents.

In all of these experiments, the subjects have been active participants. But another interesting aspect of these objective tests is that it is not a requirement for the test subject to be conscious. Even while sleeping, we are able to draw objective data on how the tactile experience affects the wearer. Because the areas that we test continue to react and respond, regardless of the state of consciousness.

The benefits of these newly-developed objective measurement techniques are providing insights into the mind-body connection and providing ways to reduce or eliminate stress and also improve the general health of the wearer.

There are both positive and negative aspects of the effects of fashion on the human body. Considering that clothes are in contact with the body most of the time and have some continuous influences, fashion should be both healthy and comfortable, or at least, have no negative effect on the body. Recently, various fabrics using progressive high-technology, such as nano-fiber, have been developed. However, the characteristics or safety of such fabrics have not been established.

The need for objective evaluation of the effects of fashion on the human body will increase greatly in the near future. The present studies consisted of trials, and the results obtained suggest the possibility of objective evaluation by measuring physiological and autonomic nervous system responses and endocrinological activity.

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