

Relationship between Emotional State and Physiological and Psychological Measurements Using Various Types of Video Content during TV Viewing

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Abstract. Using 42-inch plasma screens and showing four kinds of content, we experimentally evaluated the relationship between TV viewers' emotional state and selected physiological and psychological indices. Our results indicate that near-infrared spectroscopy (NIRS), representing nervous system activity, is a potentially useful index for evaluating emotional states that include "stressed—relaxed," "comfortable—uncomfortable," and "like—dislike." However, LF/HF and HR are affected by complex emotional states in each subject.

Keywords: Emotional states, physiological and psychological measurements, NIRS, Heart rate variability, TV viewing.

1 Introduction

Technological progress and changing lifestyles have led to significant changes in the everyday TV viewing environment. Bigger screens, and TV viewing styles that are becoming more diverse due to broadening content, such as video games and Web pages in addition to conventional TV programs, make it increasingly necessary to consider the effects of these changes on visual fatigue and health. Our previous study investigated visual fatigue with the aim of proposing optimum TV viewing conditions that correspond to the content being viewed and which do not cause eye strain [1]. However, measurements of users' emotional states in addition to visual fatigue are an essential element in designing and developing TVs to minimize visual fatigue while creating a sense of involvement and enjoyment. Current evaluation methods of viewers' emotional states depend chiefly on reports by subjects; however, these evaluations often show considerable variation between individuals. Thus, to be able to improve the accuracy and usefulness of these types of evaluations, it is necessary to measure emotional states objectively. In this study, the authors used both a physiological and a psychological approach. In our psychological evaluation, we

employed questionnaires and interviews, and attempted to build an objective index of emotional state from two or more physiological indices.

2 Experiment

In the experiment, the participants engaged in TV viewing of four kinds of video content (a recorded concert, scenery, horror, and heartwarming material). Each participant watched all four 10-minute clips in one session, with a two-minute rest period before and after each clip. Physiological indices were monitored while the subjects performed the viewing test.

2.1 Methods

Subjects. Twelve adults aged from their 20s to 30s participated in this experiment.

Measurements. The following items were investigated.

1. Psychological state (“stressed—relaxed,” “aroused—sleepy,” “focused—distracted,” “feeling of involvement—bored,” “comfortable—uncomfortable,” “like—dislike,” “interest,” “excitement,” “fear,” and “visual fatigue”), reported on a scale of 3 to −3, through questionnaires and interviews.
2. Near-infrared spectroscopy (NIRS): brain activity based on total hemoglobin or oxyhemoglobin, obtained by NIRS (NIRS detectors were placed on the left and right of the subject’s forehead),
3. Heart rate (HR) and heart rate variability (level of sympathetic nerve activity: LF/HF (LF/HF is defined as the ratio of the low frequency band (LF: 0.04–0.15 Hz) to the high frequency band (HF: 0.15–0.5 Hz) [2] [3], calculated employing FFT analysis using the R-R interval based on heart rate variability obtained via an electrocardiogram),
4. blinking rate, and
5. β/α (Electroencephalogram: EEG; Cz reference).
6. Viewing distances: 165 cm (3H; H is the display height. H of a 42-inch screen is about 55 cm.).

Apparatus

1. The display device was a plasma TV (PDP) (Panasonic TH-42PX600; resolution: HD 1024 x 768, aspect ratio: 16:9, with a 42-inch screen.
2. The viewing distance was set at 3H (165 cm). Viewing distance was defined by screen-to-eye distance in terms of the height (H) of the screen. The display height of the 42-inch screen was set at 55 cm.
3. Test room conditions were maintained at constant levels: ambient temperature of 23 °C, relative humidity of 50%, and illumination of 150 lx. Humidity, which affects blinking rates, was strictly controlled. Illumination was set at 150 lx to simulate the average light level of a Japanese living room based on JIS standardization.

Procedure. Each trial included a 10-minute viewing test, with 2 minutes' rest time between tests. After each trial, the subject gave an assessment of their psychological state, on a scale of 3 to -3. Each item in the questionnaire included three parts: the first part for the early stage, the second for the intermediate stage, and the third for the last stage of the 10-minute viewing test. The order of type of content was different for each subject, chosen using a Latin square. Each trial consisted of two minutes' rest, followed by the ten-minute viewing test, and ended with another two minutes' rest. To prevent buildup of fatigue, a rest, lasting ten minutes, was scheduled between each trial. The measurement items were monitored during the tests.

2.2 Results and Discussions

Correlation among NIRS, HR, LF/HF of HR variability, blinking rate, β/α (EEG) and the subjects' evaluation of their psychological state: The results showed that brain activity, as measured by NIRS (total Hb), decreased in subjects who gave higher scores for "comfortable," with a significant correlation in nine of the twelve subjects; and for "like," and "relaxed," and there was a significant correlation in eight of the twelve subjects; but this was not the case for "feeling of involvement" (Table 1). Some subjects (S2, S4, S6, S7, S11, S12) gave higher scores for "uncomfortable," "dislike," "stressed," and "feeling of involvement," when viewing "horror." Other subjects (S1, S5, S8) gave higher scores for "comfortable," "like," and "feeling of involvement," when viewing "heartwarming material."

These results indicated that NIRS is a potentially useful index for evaluating emotional states that include "stressed—relaxed," "comfortable—uncomfortable," and "like—dislike." Heart rate (HR) rose with higher scores given by some subjects for "comfortable," and "like," but others showed the opposite pattern, with HR rising for high "uncomfortable" and "dislike" scores (Table 1). In six of the twelve subjects, LF/HF also rose, showing a significant correlation with higher scores for "comfortable," but showed the opposite pattern in two of twelve (Table 1). In six of the twelve subjects, LF/HF also rose, showing a significant correlation with higher scores for "relaxed," but in two of twelve, showed the opposite pattern (Table 1). These results indicate that LF/HF and HR are affected by complex emotional states in each subject.

In Figure 1, (a) and (b) show the relationship between the two psychological axes for horror content, and (c) and (d) in Figure 1 show those for heartwarming content. Figures plotted on the X-axis (score for stressed—relaxed) and the Y-axis (score for comfortable—uncomfortable) tended to follow the function ($Y = -X$). This relationship was independent of type of content, as seen in (a) and (c). On the other hand, figures plotted on the X-axis (score for stressed—relaxed) and Y-axis (score for feeling of involvement—bored) tended to follow the function ($Y = -X$) ((d): heartwarming material) or the function ($Y = X$) ((b): horror), and this relationship was dependent on type of content.

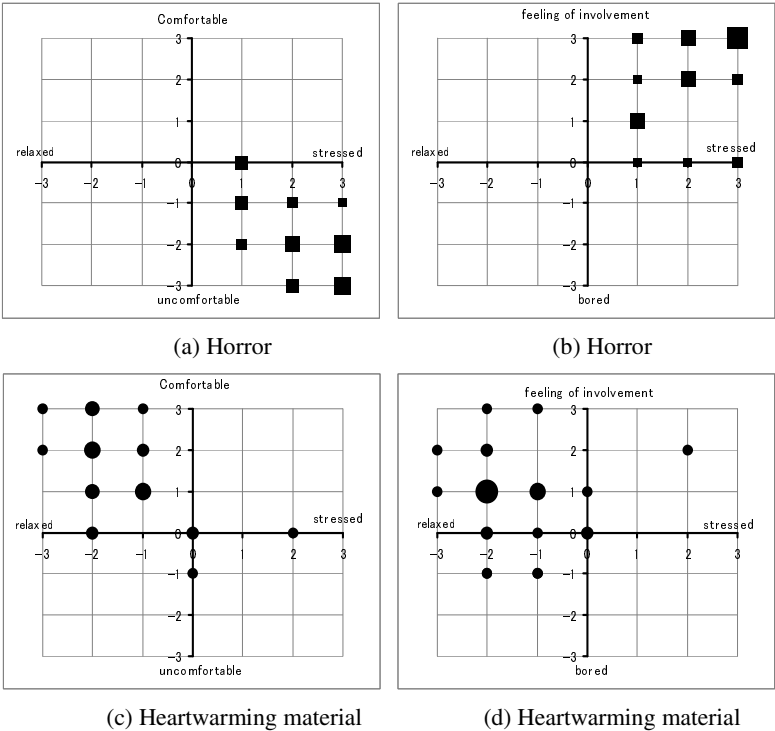


Fig. 1. (a) and (b) in Figure 1 show the relationship between the two psychological axes for horror content, and (c) and (d) in Figure 1 show those for heartwarming material content. The X-axis for (a)-(d) in Figure 1 indicates the subjects' scores for the "stressed—relaxed" psychological state. The Y-axis for (a) and (c) in Figure 1 indicates scores for ("comfortable—uncomfortable"). The Y-axis for (b) and (d) in Figure 1 indicates scores for "feeling of involvement—bored." The font size of the plot markers (●, ■, ◆ and ▲) on the graph grid indicates the number of points that were selected by subjects as their psychological scores. The total number of points was 36 (12 (the number of subjects) x 3 (each item in the questionnaire included in the three parts)). The scale of font sizes is 1 to 7 points.

Table 1. Correlation between physiological and psychological states

	like -dislike			stressed- relaxed		
	NIRS	HR	LF/HF	NIRS	HR	LF/HF
S1~S8	N	NULL	P	P	NULL	NULL
S1	NULL	P	N	NULL	NULL	N
S2	N	N	P	P	P	N
S3	N	N	P	NULL	P	N
S4	P	N	NULL	P	N	P
S5	N	P	P	P	N	N
S6	N	N	NULL	P	P	NULL
S7	NULL	N	P	P	P	NULL
S8	N	NULL	P	P	NULL	N
S9	NULL	NULL	N	NULL	N	N
S10	N	N	N	N	N	N
S11	N	N	N	P	P	P
S12	N	NULL	N	P	NULL	NULL

Table 1. (*Continued*)

	comfortable-uncomfortable			feeling of involvement-bored		
	NIRS	HR	LF/HF	NIRS	HR	LF/HF
S1 ~ S8	N	NULL	P	NULL	NULL	NULL
S1	NULL	P	P	N	P	N
S2	N	N	P	P	P	N
S3	N	N	P	NULL	P	P
S4	N	P	NULL	P	N	P
S5	N	P	P	N	N	NULL
S6	N	N	NULL	P	P	NULL
S7	N	N	P	P	P	NULL
S8	N	NULL	P	N	NULL	P
S9	NULL	NULL	NULL	P	N	N
S10	NULL	NULL	NULL	N	N	N
S11	N	N	N	P	P	P
S12	N	NULL	N	P	N	N

3 Conclusions

NIRS appears to be a potentially useful index of emotional states, including “stressed—relaxed,” “comfortable—uncomfortable,” and “like—dislike.” However, LF/HF and HR are affected by complex emotional states in each subject, since there were significant negative correlations for some subjects and positive correlations for others between these indices.

Further investigations will be needed to gain a more precise picture of the relationship between emotional state and physiological and psychological measurements when viewing various types of content.

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