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Electric Dermal Activity Judges Funny Comedian Videos

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Abstract: The need for technology to predict subjective experiences based on physiological signals has increased. Our study investigated the relationship between the comicalness of comedian videos and skin conductance responses recorded while watching videos. Through a user study involving eleven participants, subjective scores of a video's funniness were predicted by multiple linear regression analysis using five types of feature values computed from skin conductance responses. We found that the most influential feature is the number of local peaks in the skin conductance response per unit of time. The correlation coefficient between the observed and predicted funniness scores is 0.53. These findings are useful for the objective evaluation of entertainment experiences.

Keywords: *Emotion, Skin conductance, Funniness, Comedy*

1. INTRODUCTION

A growing number of researchers have been studying methods to estimate human emotions based on physiological signals to provide services related to users' feelings. For example, an ordering system recommends food items to customers from their facial expressions and eye motions [1], and a therapist system infers users' emotions from facial expressions and voices to support their mental states [2]. Previous studies aimed to detect laughter based on facial expressions, voices, and electromyograms related to laughter behaviors, rather than to estimate subjective fun [3]–[6]. In some situations, sensors for measuring these signals are unavailable. Furthermore, funniness does not always lead to laughing. Therefore, as a novel approach to previous investigations, we used skin conductance. Skin conductance is a measure of arousal and represents the change in the electrodermal activity of the skin due to sweating associated with arousal such as fear, surprise, and pleasure. Skin conductance is relatively free from privacy issues compared with facial pictures and voices. Hence, skin conductance is preferred in some scenarios.

The objective of this study was to predict subjective funniness scores reported by viewers after watching comedy videos based on the features of skin conductance. In particular, we searched for features that were effective for prediction.

This study was approved by the institutional review board of the Hino Campus, Tokyo Metropolitan University (H22-014).

2. METHODS

2.1 Stimuli: Comedians' Talk Movies

We used a total of ten Japanese comedy videos, each of which was two to six minutes long. To include videos with a variety of funniness levels, three or four comedians were selected from each of the three levels of popularity: very, moderately, and mildly popular comedians.

2.2 Participants

A total of eleven university students and lecturers in their 20s and 30s participated in the experiment providing informed consent, and were unaware of the experiment's purpose.

2.3 Apparatus

The skin conductance was measured using a dermal electrical activity sensor (AP-U030m II, Nihon Suntech, Japan) and an amplifier (MaPI720CA, Nihon Suntech, Japan). These were connected to a data acquisition device (NI USB-6211, National Instrument Corp., TX) and controlled by the *Data Acquisition Toolbox* in MATLAB (MATLAB 2021a, Mathworks, MA). The responses were measured at a sampling frequency of 100 Hz. Videos were played for the participants on a 21-inch display placed 60 cm away from and on headphones. A similar system was adopted in [7, 8].

2.4 Procedures

Individual participants attached electrodes to the second and fourth fingers and rested for ten minutes. Before

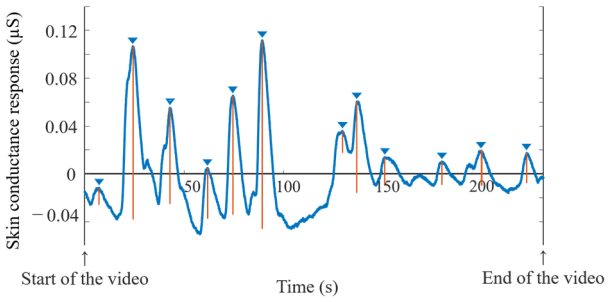

Figure 1: Example of the temporal changes in skin conductance responses while watching a comedy video. Inverse triangles indicate the local peaks, and red lines indicate the peaks' amplitudes.

viewing each video, the participant rested for approximately 1–2 min until their skin conductance response was judged to have reached a steady state. They watched six or seven randomly selected videos in a random order. For each participant, the rating of the first video was fixed at five as a reference.

They then scored the funniness of each succeeding video using a nine-point scale. The participants were encouraged to use a wide range of scores to reflect the differences in funniness between the videos.

2.5 Data Analysis.

A total of 68 samples were obtained in the experiments. Of these, we excluded cases of invalid measurements in which the contact state of the electrode changed owing to hand motion. Furthermore, samples in which no peaks of skin conductance response were observed were removed due to inability to compute their feature values. Finally, 53 samples were used for the latter analysis.

From the measured skin conductance responses, 16 features were computed for each video for each participant. All feature variables were normalized using z-scores for the individual participants. Multiple linear regression analysis was performed using the 16 features as explanatory variables to estimate funniness scores. A stepwise method was used to select the effective variables to maximize R^2 values. Five types of features were selected, as explained below.

To calculate the features, as shown in Figure 1, we defined the peaks of the skin conductance response as satisfying the following conditions:

- Those greater than the right and left-side local minimums by 0.01 μS
- The duration of the peak, during which the skin conductance response values are greater than half the peak value, range 2 to 20 s.

The five skin conductance features adopted in the analysis

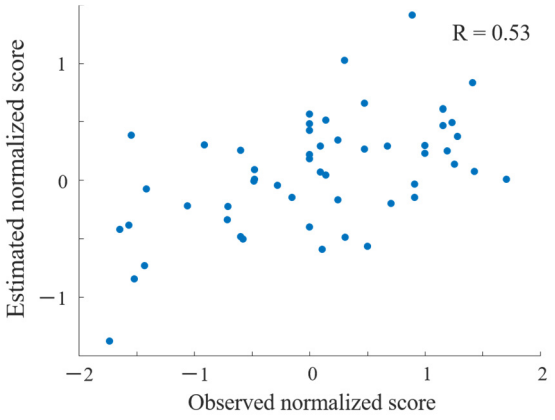

Figure 2: Observed and estimated funniness scores.

Table 1: Partial regression coefficients to predict funniness scores.

Feature	Regression coefficient	p value
Coefficient of variation of peak amplitude	0.24	0.098
Density of peaks	−0.43	0.0063
Number of moderate peaks	0.32	0.041
Integral of skin conductance response	0.29	0.042
Altitude center of skin conductance response	−0.18	0.19

were as follows:

- Coefficient of variation of peak amplitude of skin conductance responses: ratio of the standard deviation of peak amplitude values to their mean.
- Density of skin conductance response peaks: the number of peaks in the skin conductance response in the video divided by the video duration.
- Number of moderate peaks: the number of moderate peaks while watching a video. Moderate peaks were defined as those whose peak amplitudes were included in the top 25%–50% within the peaks of individuals.
- Integral of skin conductance response: integral value of skin conductance response while viewing a video.
- Altitude center of skin conductance response: first order moment of skin conductance, which was calculated by:

$$\frac{1}{\sum_{k=0}^{T/\Delta t} c_k} \boldsymbol{t}^{\mathrm{T}} \boldsymbol{c} \tag{1}$$

where $t = \left(0, \Delta t/T, 2\,\Delta t/T, \ldots, (T-\Delta t)/T, 1\right)^{\mathrm{T}}$ is a column vector of normalized time stamp with Δt being the sampling period: 0.01 s. T is the length of the video in seconds. The size of $\boldsymbol{t}$ is $T/\Delta t + 1$. $\boldsymbol{c}$ is a column vector of skin conductance response value, and c_k is the kth element of $\boldsymbol{c}$.

3. RESULTS

Figure 2 shows a scatter plot of the observed and predicted funniness scores, where the correlation coefficient R is 0.53 and the adjusted R^2 is 0.20.

Table 1 shows the partial regression coefficients for the five features of multiple linear regression analysis. The significant features were density of peaks, number of moderate peaks, and the integral of skin conductance response. Of these, the density of the peaks had the greatest influence on prediction.

4. DISCUSSION

The subjectively reported funniness was estimated by using the features of skin conductance responses with the correlation coefficient between observation and estimation being R = 0.53. The density of skin conductance response peaks was the most effective and significantly negative, suggesting that the fewer the peaks in the time-series of skin conductance response while watching a video, the funnier the video was. By contrast, the greater the number of moderate peaks, the funnier was the video. These analyses suggest that videos with moderately funny scenes felt more comical than those containing many mildly funny scenes. The integral of the skin conductance response positively influenced subjective funniness, indicating that enjoyable comedy videos result in high activity in skin conductance.

5. CONCLUSION

Our study attempted to infer the subjective funniness of the audiovisual content based on skin conductance responses. Our results concluded that the density of the skin conductance response peaks, number of moderate peaks, and integral of skin conductance response while watching a video are significant predictors of funniness.

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