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Assessing Interest Level during Movie Watching with Brain Potentials

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Abstract

The present study examined whether event-related potentials (ERPs) can be used to reflect a participant's level of interest in an ongoing audiovisual experience. Previous studies showed that the ERPs elicited by auditory or somatosensory (vibratory) probe stimuli were reduced in amplitude while participants were watching an interesting video clip as compared to a boring video clip or still picture. In these studies, participants had to respond selectively to a target stimulus embedded in two or three types of stimuli. However, such a discrimination task may be too distractive to allow the participant to concentrate on the video clips. In the present study, we used a simple reaction-time (SRT) task using a vibratory stimulus to examine whether the ERPs elicited by a single probe stimulus can differentiate between interesting and boring movies. Eighteen university students performed a somatosensory SRT task while watching new video clips (interesting condition) or video clips that they had already seen four times (boring condition). The vibratory probe stimulus was presented either on the left or on the right hand and required an immediate button-press response with the thumb of the same hand. The probe stimulus elicited an N140 wave, the amplitude of which was smaller while participants were viewing interesting video clips than while viewing boring video clips. Moreover, the alpha-band (8.0–12.5 Hz) power of the background electroencephalogram (EEG) was attenuated in the interesting condition as compared to the boring condition. The combination of the amplitude of the N140 elicited by a vibratory probe stimulus and the power of alpha-band EEG activity may be a useful objective index of how strongly an audiovisual experience attracts a viewer's interest.

Key words: *Interest, Attention, Video clips, Probe stimulus technique*

Introduction

In daily life, we consider various audiovisual experiences (e.g., TV programs, movies, lectures, and plays) to be interesting, boring, enjoyable, or awful. Although such attitudes can be assessed by introspection, they do not necessarily reflect the actual psychological states held during the experience. Retrospective reports are often biased, and not all psychological states can be expressed verbally. To complement the weakness of subjective measures, physiological measures would be useful to assess the ongoing attentional and emotional processes of participants without asking them directly. The present study examined whether event-related potentials (ERPs) can be used to reflect a participant's level of interest in the audiovisual experience of watching video clips.

The probe stimulus technique has been used to gauge the amount of attention given to a certain task by using probe stimuli that are unrelated to the main task (Papanicolaou & Johnstone, 1984). This technique, also known as the secondary task technique, is based on the limited capacity model of attention. A previous study has shown that the P300 wave of the ERP elicited by auditory probe stimuli was reduced in amplitude while participants were watching an interesting video clip as compared to a boring video clip or still picture (Suzuki, Nittono, & Hori, 2005). Although this method appears to be promising, auditory probe stimuli may not be practical because they are perceptually masked when other auditory materials are present.

Recently, a new somatosensory (vibratory) probe stimulus technique was developed to solve this masking problem (Shigemitsu, Nittono, & Hori, 2007). The inverse relationship between the P300 amplitude and the

interest in movies was replicated in a somatosensory target detection task. In the present study, we revise this method by using a simple reaction-time task to reduce the participants' workload related to stimulus discrimination. Moreover, we examined background electroencephalograms (EEGs) in the periods when vibratory stimuli were not presented. It is known that the alpha-band EEG activity at occipital sites is more attenuated when participants perform a demanding task than when they perform an effortless task or rest (Pellouchoud, Smith, McEvoy, & Gevins, 1999; Smith, Gevins, Brown, Karnik, & Du, 2001). Interesting movies would thus attenuate the alpha-band activity more than boring movies.

Methods

Participants

Eighteen student volunteers at Hiroshima University participated in the study (5 men and 13 women, 20–26 years old, M = 22 years old). All of them were right-handed and had normal or corrected-to-normal sight and normal hearing. They gave written informed consent.

Stimuli

A vibration motor (FM23A, Tokyo Parts Industrial Co., Ltd.) of a type often used in cell phones was implemented in a handgrip apparatus and used to produce a vibratory stimulus of 50–60 Hz. The stimulus duration was 200 ms. Half of the participants held the apparatus with the right hand and the other with the left hand. The onset-to-onset interval of the stimuli varied randomly from 2 to 14 s (M = 8 s). In the audiovisual condition, two video clips (6.5 minutes each) were extracted from comedy films and presented on a 10-inch display placed 1.5 m before the participants' eyes, with soundtracks emitting from loudspeakers. In the picture condition, a simple still image (e.g., a picture of an animal) was presented on the display with pink noise.

Procedure

The participants' task was to press a button embedded on the handgrip apparatus with the thumb of the same hand as quickly as possible whenever the stimulus occurred. There were three experimental conditions (45 stimuli/6.5 min each): interesting video, boring video, and still picture. The order of the conditions was counterbalanced across participants. The probe stimulation started 15 s after playing each video clip and lasted 6 min (until the end of the video clip). Participants were told that they would be asked about their impressions of the video clip after each condition, but that they did not have to remember the details. Before the experiment, participants went through a 6-minute practice block to become familiar with the task. There was a short break after each experimental condition during which participants were asked how much attention they allocated to the probe stimuli (1: minimum–9: maximum), how much attention they allocated to the video clip (1: minimum–9: maximum), and how interesting they found the video clip (1: very uninteresting–9: very interesting).

Physiological Recording

An electroencephalogram (EEG) was recorded from 33 scalp sites using an elastic cap with Ag/AgCl electrodes. The data were re-referenced to the nose tip offline. Horizontal and vertical electrooculograms (EOGs) were recorded from the outer canthi of both eyes and from above and below the left eye. Electrode impedance did not exceed 5 kΩ. At recording, a time constant of 5 s and a low-pass filter of 120 Hz were used. The sampling rate was 500 Hz.

Data Reduction

Correct responses were defined as button presses within 200–1,000 ms after the onset of vibration stimuli. After applying a digital bandpass filter of 0.05–100 Hz, ocular artifacts in EEG traces were corrected using Gratton et al.'s (1983) method. ERP waveforms were calculated separately for each participant and condition. The period between 200 ms before and 1,000 ms after stimulus onset was averaged. Whenever EEG or EOGs exceeded ±80 μV, the periods were excluded from the averaging. Each ERP waveform was aligned to the 200-ms prestimulus baseline by subtracting the mean amplitude of this period from each point of the waveform. The amplitudes of two ERP components were scored. N140 was defined as the maximal negative peak between 120 and 180 ms after the onset of vibration stimulus. P300 was defined as the maximal positive peak between 250 and 600 ms after stimulus onset. Peak amplitude and latency were measured at the most dominant site (Cz for N140 and Pz for P300).

To analyze the background EEG, 21 artifact-free periods of 2,048 ms each that did not contain any vibratory

stimulus were selected for each condition and analyzed using the fast Fourier transform (FFT) with the Hanning window. The spectra were then averaged across the 21 periods and the mean power in the alpha band (8.0–12.5 Hz) was computed at the occipital midline site, Oz.

Statistical Analysis

Subjective, behavioral, and physiological measures were submitted to one-way repeated measures analyses of variance (ANOVAs) with a factor of condition. To control Type I error in the ANOVAs, the Huynh–Feldt ε correction for the violation of the sphericity assumption was applied to the degrees of freedom greater than one. The significance level was set at .05. Post hoc multiple comparisons among three conditions were made using a modified sequentially rejective multiple test procedure (Shaffer, 1986).

Results

Manipulation Check

The means ± standard errors of the interest ratings on video clips were 7.4 ± 1.3 and 5.3 ± 2.0 for the interesting and boring conditions, respectively. A one-way ANOVA showed a significant effect of condition, $F(1, 17) = 20.73$, $p < 0.001$. This result validates the adequacy of experimental manipulation in this study.

Subjective and Behavioral Measures

The means ± standard errors of the subjective ratings on the amount of attention allocated to video clips were 7.6 ± 1.1 and 5.6 ± 1.7 for the interesting and boring conditions, respectively. The subjective ratings on the amount of attention allocated to vibration stimuli were 2.8 ± 1.7, 4.6 ± 2.3, and 6.4 ± 2.0 for the interesting, boring, and picture conditions, respectively. The scores varied significantly across conditions. Multiple comparisons showed that participants subjectively allocated more attention to the video clips and less attention to the probe stimuli in the interesting condition as compared with the boring condition. The mean reaction time was 273 ± 6 ms and did not differ significantly across conditions. There were almost no errors, 2.8 % on average.

ERPs

Figure 1 shows the grand mean ERP waveforms elicited by the vibration stimulus. In all conditions, the stimulus elicited a negative wave (N140) about 140 ms after stimulus onset, which was followed by a positive wave (P300).

Figure 2 illustrates the mean amplitudes of the N140 at Cz and the P300 at Pz. For the N140, an ANOVA showed a significant effect of condition, $F(2, 34) = 12.51$, $p < .001$, $\varepsilon = .99$. Multiple comparisons showed that the N140 amplitude was smaller in the interesting than in the boring condition, which was in turn smaller than in the picture condition. The latency of the N140 did not differ significantly between conditions ($M = 141 \pm 3$ ms). For the P300, an ANOVA showed a significant effect of condition, $F(2, 34) = 3.59$, $p < .05$, $\varepsilon = 1$. Multiple comparisons showed that the P300 amplitude was significantly

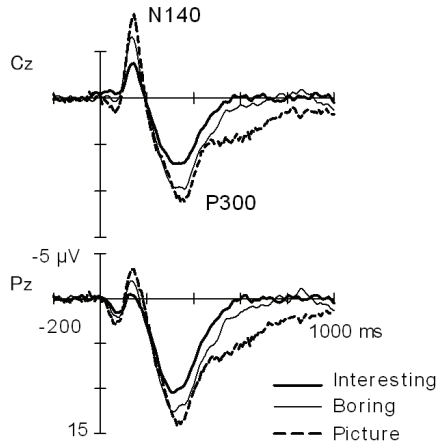

Figure 1. Grand mean ERP waveforms elicited by vibratory stimuli in the three viewing conditions ($N = 18$). All recordings were referenced to the nose tip. Vertical lines indicate the stimulus onset.

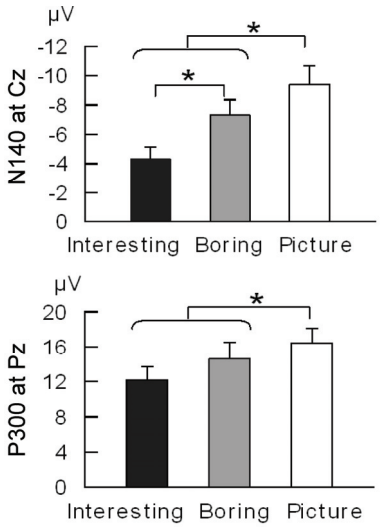

Figure 2. Mean amplitudes of the N140 and P300 in the interesting, boring, and picture conditions.

larger in the picture condition than in the two video conditions, which did not differ significantly from each other. The latency of the P300 did not differ significantly between conditions ($M = 433 \pm 7$ ms).

Background EEG

Figure 3 illustrates the mean powers of the alpha-band activity at Oz. An ANOVA showed a significant effect of condition, $F(2, 34) = 10.33$, $p < .005$, $\varepsilon = .58$. Multiple comparisons showed that the alpha-band power was attenuated gradually from the picture condition to the interesting video condition.

Discussion

According to subjective reports, participants allocated less attention to auditory probes when viewing interesting video clips than when viewing boring video clips or still pictures. Behavioral measures were not sensitive to the differences in the level of interest.

The amplitude of N140 was significantly smaller when participants were viewing interesting video clips than when viewing boring video clips. The N140 is specific to somatosensory stimulation and its amplitude is known to vary with attention (Kida, Nishihira, Wasaka, Nakata, & Sakamoto, 2004). The P300 showed a similar tendency, but it did not reach the significance level. In our previous study, the N140 was not observed (Shigemitsu et al., 2007). This is probably because the mean interstimulus interval was shorter than that used in the present study (1.2 s vs. 8.0 s). If sufficiently long intervals are inserted between the stimuli, the N140 elicited by vibratory stimuli may be a more sensitive measure of attention than the P300.

The alpha-band power of the background EEG was also attenuated in the interesting condition compared to the boring condition. This EEG result agrees with previous findings (Pellouchoud et al.1999; Smith et al., 2001).

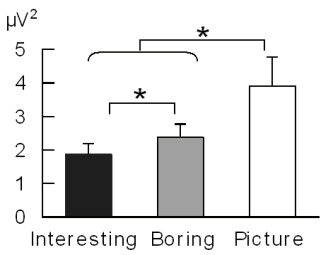

Figure 3. Mean EEG powers of the alpha band (8.0–12.5 Hz) in the interesting, boring, and picture conditions.

The combination of the amplitude of the N140 elicited by a vibratory probe stimulus and the power of the alpha-band EEG activity may be a useful objective index of how strongly an audiovisual experience attracts a viewer's interest.

Acknowledgments

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