

# The Effects of the Timing of Commercial Breaks by the Measurement of Brain Activity using fNIRS and Autonomic Nervous Activity

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**Abstract** Recently commercial breaks are often inserted just before the climax of stories in TV programs in Japan. One article reports that commercials inserted just before the climax will dissatisfy the audience and discourage their concentration. In this research, we study the effects of the timing of commercial breaks by the measurement of brain activity and autonomic nervous activity. As a result, it is suggested that the involuntary disengagement of attention is caused the abrupt onset of the commercial break just before the climax giving audiences an unpleasant feeling. Furthermore, the results show the possibility that presenting the climax of the story just before the onset of the commercial break increases the working memory load of watching the commercial break after the climax.

## 1 Introduction

Concentration is very important in various fields, such as media, entertainment and training. Concentration requires focusing the attention on a target object or behavior. Concentration is the key to success in business and sport, thus we often talk about how to develop our powers of concentration and what its mechanism is.

Recently commercial breaks are often inserted just before the climax of stories in TV programs in Japan. By placing TV commercials just before the climax, the producer intends us to watch both the commercial and the continuation of the story without fail. However, commercials inserted just before the climax will make the audience dissatisfied and discourage their concentration [1]. There has been research about the effects of the timing of commercial breaks by measuring the autonomic nervous system activity [2], but it does not follow the brain activity. Various research on concentration on the media have been published in the field of neuroscience [3, 4], in which it is shown that there is a relationship between

concentration and brain activity.

In this research, we studied its effects by measuring not only autonomic nervous activity but also brain activity.

## 2 Method

### 2.1 Participants

Twenty one healthy right-handed Japanese undergraduates (all males, aged 18 to 22 years old) participated in this study. All participants provided their informed consent for their participation.

### 2.2 Procedure

Each participant took a chair in front of a 19-inch liquid crystal display in a shielded chamber. The distance between the participant and the display was 1.5 m. Participants watched two versions of a documentary TV program of 30 minutes that contained 5 stories, 1 replay and 3 commercial breaks. The contents of the two versions (Ver. A and Ver. B) were identical, and only the timing of the commercial breaks and whether a replay was presented or not were changed (Fig. 1).

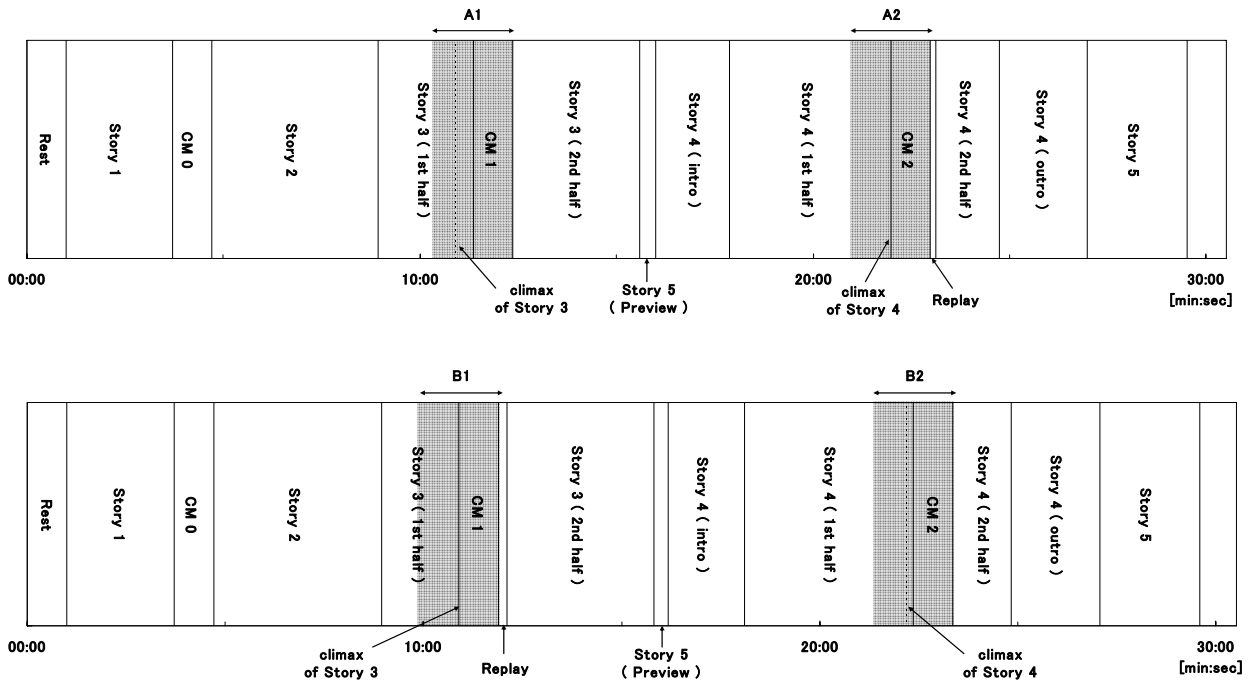


Fig. 1: The sequences of the two versions of the TV program. The TV program contains five stories each with different content, one replay and three commercial breaks. Each commercial break is one minute long (4 contents  $\times$  15 seconds). CM0 is inserted between the end of Story1 and the beginning of Story2. (a) Ver. A. CM1 is inserted just after the climax of the Story 3. CM2 is inserted just before the climax in Story 4. Replay is the same as the last 8 seconds in Story 4 (1st half). The segments colored gray are the targets for analysis. (b) Ver. B. CM1 is inserted just before the climax of the Story 3. CM2 is inserted just after the climax of the Story 4. The segments colored gray are the targets for analysis.

In Ver. A, one of the commercial breaks (CM1) was inserted after Story 3 reached its climax, and another commercial break (CM2) interrupted Story 4 just before the story reached its climax. In Ver. B, CM1 interrupted Story 3, and CM2 was inserted after Story 4 reached its climax. Eleven out of 21 participants watched Ver. A, and 10 participants watched Ver. B.

We measured the brain activity in a  $6 \times 21$  cm area centered in the Fz of an EEG 10-20 system [5] using fNIRS (Fig. 2) with a sampling frequency of 10 Hz. The heart rate, eye blink, respiration and perspiration of the participants while watching the program were measured with a sampling frequency of 1000 Hz. We also measured these activities during one minute rest periods just before and after watching the program. During the rest periods, participants were asked to relax and concentrate on the center of the liquid

crystal display without pictures or sounds. After the measurement, participants completed a questionnaire assessing their impressions of the program.

### 2.3 Data Analysis

The data acquired from fNIRS are oxyHb, deoxyHb and totalHb. OxyHb and deoxyHb are the products of optical path length between the paired light emitter and detector by the changes in the concentration of oxygenated hemoglobin and deoxygenated hemoglobin. TotalHb is calculated by the following equation.

$$totalHb = oxyHb + deoxyHb$$

No calculation or comparison across participants and channels on raw data was allowed because of the difference of the optical path length. Therefore, each datum is translated by following equation, and then

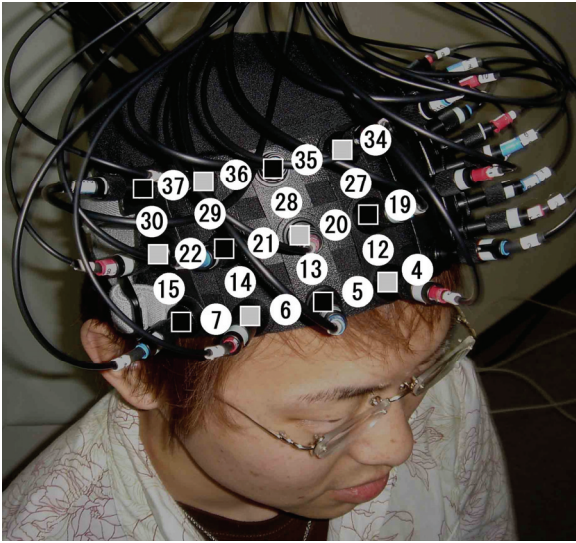
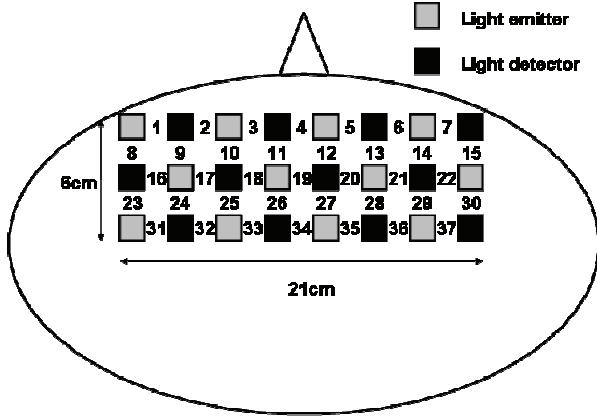


Fig. 2: The locations of light emitters, light detectors and measuring channels. The paired emitter-detector interval is 3 cm. Channel 19 is located on Fz. 37 channels covered 6 cm × 21 cm area over the frontal region of the head to measure the prefrontal cortex (PFC).

averaged across participants who watched the same version of the stimulation.

$$oxyHb' = \frac{oxyHb - oxyHb_{CM}}{SD}$$

$$deoxyHb' = \frac{deoxyHb - deoxyHb_{CM}}{SD}$$

$$totalHb' = \frac{totalHb - totalHb_{CM}}{SD}$$

Table 1: The target segments for analysis and insertion timing of each commercial break

		Inserted commercial break	
		CM1	CM2
Stimulation	Ver. A	<b>A1</b> CM1 is inserted just <i>after</i> the climax of Story3.	<b>A2</b> CM2 is inserted just <i>before</i> the climax of Story 4.
	Ver. B	<b>B1</b> CM1 is inserted just <i>before</i> the climax of Story3.	<b>B2</b> CM2 is inserted just <i>after</i> the climax of Story 4.

Subscript symbol CM means the timing of the beginning of commercial breaks, and SD means the standard deviation of oxyHb, the most stable 30 seconds in the rests. The SD of oxyHb is employed because it is said that oxyHb is the most sensitive indicator of changes in regional cerebral blood flow (rCBF) [6].

The target segments for analysis and insertion timing of each commercial break are shown in Table 1. In this work, data for one minute before and after the beginning of each commercial break (A1, A2, B1 and B2) were analyzed.

### 3 Results and Discussion

Figure 3 shows the relative changes in the concentration of hemoglobin in B1 and B2. Here, we pick out two anterior rows (1 to 15 channels) and observed large changes on the averaged oxyHb'. This area covers the prefrontal cortex (PFC). In general, many channels indicate a decrease of the averaged oxyHb' and totalHb' until the beginning of the commercial breaks, and increase after that. In detail, however, the averaged oxyHb' and totalHb' in B2 begin to increase (Fig. 3b) earlier than those in B1 (Fig. 3a). A similar pattern as in Ver. B is observed in Ver. A. To be concrete, the averaged oxyHb' and totalHb' in A1 begin to increase (Fig. 4a) earlier than those in A2 (Fig. 4b).

Goh et al. show that positive attention to video games causes dorsal PFC deactivation [7].

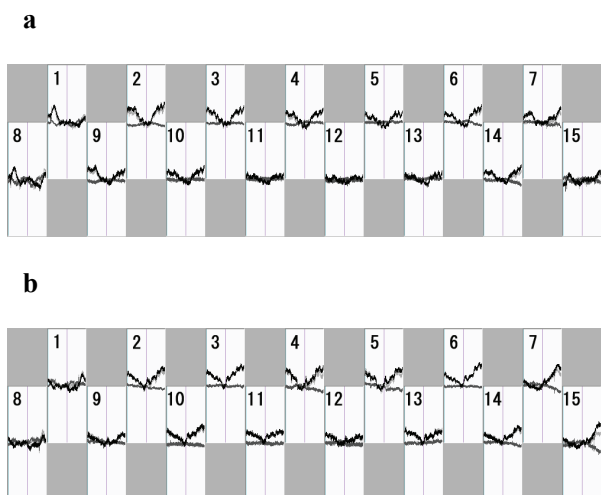


Fig.3: Averaged translated fNIRS data while watching Ver. B. The horizontal axis is time and the vertical axis is the relative changes in the concentration of hemoglobin. The width of time is 2 minutes and the vertical bars at the center mean the beginning of the commercial breaks. The black line indicates averaged oxyHb', gray indicates averaged deoxyHb' and light gray indicates averaged totalHb'. Each number represents the measuring channels. (a) In B1, many channels indicate decreases of the averaged oxyHb' and totalHb' until the beginning of the CM1, and increase after that. (b) In B2, The beginning of increases of averaged oxyHb' and totalHb' in B2 are earlier than those in B1.

Furthermore, it is said that the dorsal medial PFC, which is a part of the dorsal PFC encompasses increases in tasks that involve self-focused attention and decreases its activity in tasks that involve externally focused attention [8].

Therefore, the changes in the PFC activity in the present experiment could be attributed to a disengagement of attention from the program.

It should be noted, however, that the averaged oxyHb' increase in the climaxed condition (A1 and B2) began prior to the onset of the commercial break while the averaged oxyHb' increase in the interrupted condition (B1 and A2) began a few seconds after the onset of the commercial break. It is likely that the participant voluntarily controlled their disengagement of attention from the program in the climaxed

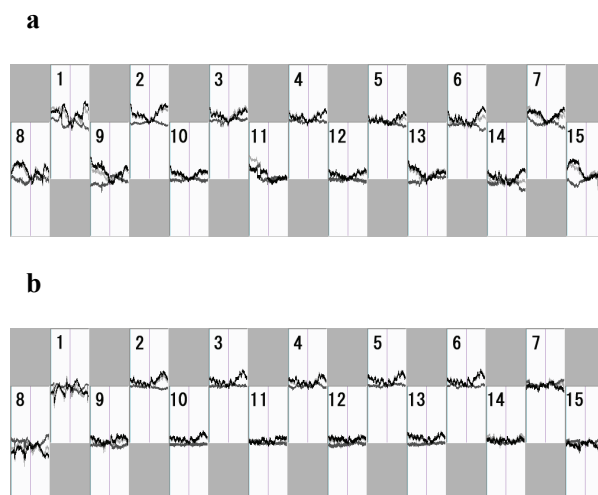


Fig. 4: Averaged translated fNIRS data while watching Ver. A. The format is same as Fig.3. (a) In A1, the beginning of increases of averaged oxyHb' and totalHb' in A1 are earlier than those in A2. (b) In A2, many channels indicate decreases of the averaged oxyHb' and totalHb' until the beginning of CM2, and increase after that.

condition, and that the participant's attention was disturbed by the abrupt onset of the commercial break in the interrupted condition. Some participants, for example, had an unpleasant feeling when the program was interrupted by the commercial break. Therefore, it is suggested that the involuntary disengagement of attention is caused the abrupt onset of the commercial break and makes audiences feel unpleasant.

Figure 5 indicates differential responses calculated by subtracting the averaged translated fNIRS data of the interrupted condition from those of the climaxed condition. Figure 5a shows that the increase of differential averaged oxyHb' in the left PFC is larger in the climaxed condition than in the interrupted condition. Figure 5b shows that the increase of differential averaged oxyHb' in the right PFC is larger in the climaxed condition than in the interrupted condition. Thus, the lateral PFC revealed a higher activity in the climaxed condition than in the interrupted condition. Since the lateral PFC is activated by a working memory task [9], this result suggests that presenting the climax of the story

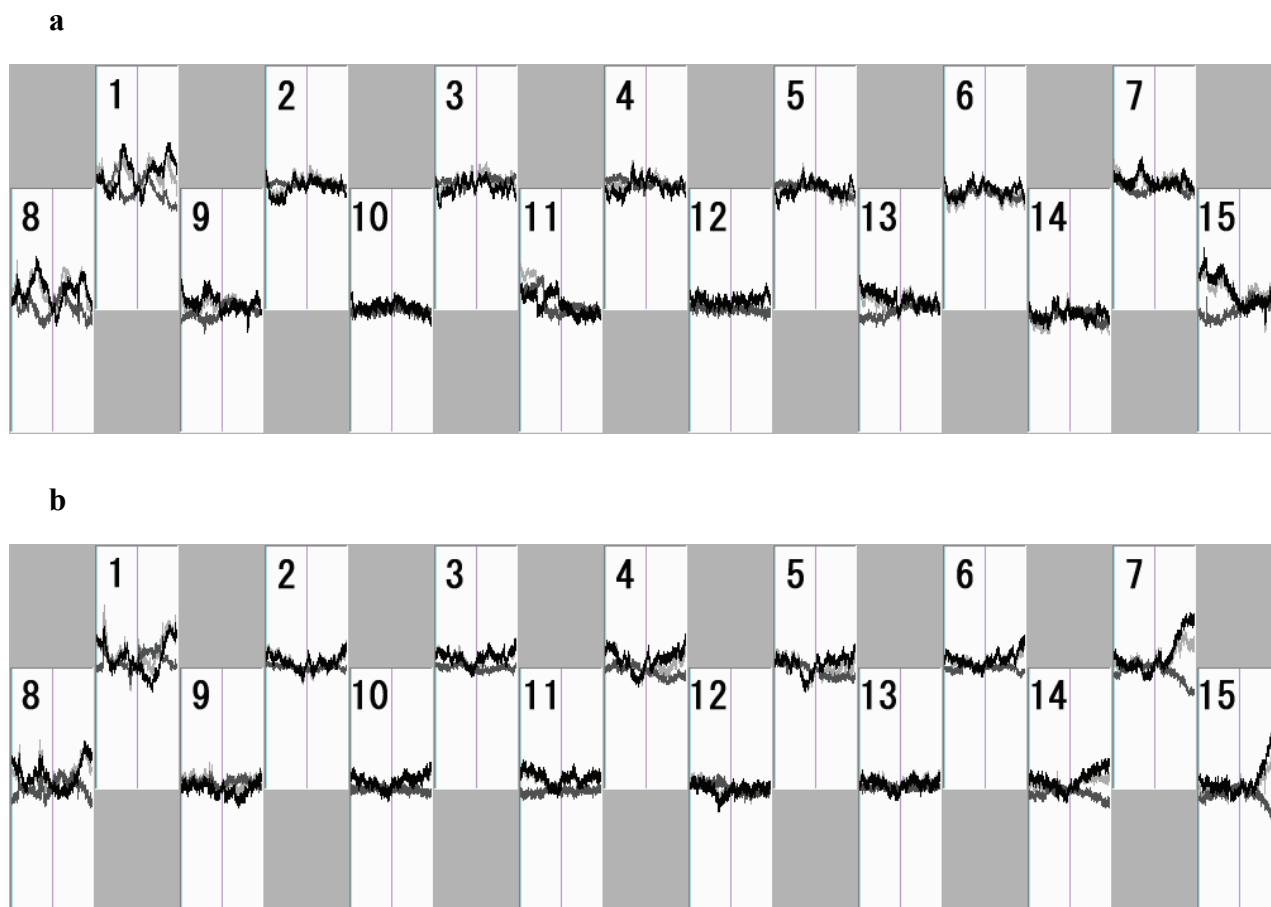


Fig. 5: Differential responses calculated by subtracting the averaged translated fNIRS data of the interrupted condition from those of the climaxed condition. (a) Differential averaged oxyHb' increase at 1 and 8 channels from just after CM1 begins. (b) Differential averaged oxyHb' increase at 7 and 15 channels from just after CM2 begins.

increased the working memory load of watching the commercial break just after the climax. Furthermore, Smith et al. showed that a verbal working memory task activates the left PFC, and that a spatial working memory task activates the right PFC [10]. Therefore, it is suggested that Figure 5a shows the difference in the verbal working memory load because the topic of Story 3 is about a song and Fig. 4b shows the difference in the spatial working memory load because Story 4 contains an image at the decisive moment.

#### 4 Conclusion

In this study, we measured brain activity and

autonomic nervous activity to estimate the effects of the timing of commercial breaks. As a result, it is suggested that involuntary disengagement of attention is caused the abrupt onset of the commercial break and make audiences feel unpleasant. Furthermore, it is suggested that presenting the climax without a break of the story increased the working memory load of watching the commercial break just after the climax.

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