Fear magnified by vibratory stimuli to the upper-body at predictive horror scenes

Tastuki Makioka
Tokyo Metropolitan University
Tokyo, Japan

Shogo Okamoto
Tokyo Metropolitan University
Tokyo, Japan

Ibuki Tara
Nagoya University
Nagoya, Japan

***Abstract*—We investigated how predictive vibratory interoceptive stimuli along with audio-visual content affected viewers' emotional experiences. It is known that vibratory stimuli to upper body presented at monster's appearance scenes of horror movies magnify fear experiences; however, arousing vibratory stimuli before such scenes also may be effective to enhance viewers' emotions. Vibration was presented at predictive scenes that suggested an incoming horror scene in videos. The predictive vibratory-interoceptive stimuli significantly increased the viewers' physiological responses which were measured as skin conductance response at fingers and subjective fear of subsequent horror scenes.**

***Index Terms*—interoception, horror movie, vibratory stimuli**

I. Introduction

Vibratory stimuli presented in conjunction with emotionally arousing scenes in audio-visual content influence viewers' subjective evaluations and physiological responses [1]–[5]. We hypothesized that stimulating the viewer's interoceptive sensations before emotionally arousing scenes enhances the emotional experience during such scenes. To date, no study has investigated this.

Although several studies have demonstrated the emotional effects of vibratory stimuli [1]–[5], the underlying principles have not been clarified. We hypothesized that vibratory stimuli to the upper body enhance emotions by affecting interoceptive sensations, mainly visceral sensations. Vibration stimuli to the upper body mechanically stimulate visceral sensations. Emotions are considered to represent the brain's representation of changes in interoceptive sensations [6]. Making the viewers of horror movies arousing by using interoceptive vibratory stimuli may affect their fear experiences at horror scenes.

In this study, we analyzed the viewers' physiological responses and subjective evaluations of watching horror videos with and without predictive vibratory stimuli and investigated the effects of vibratory stimuli at predictive scenes on the emotional experiences of succeeding emotionally appealing scenes.

II. Methods

The experimental protocols were approved by the Institutional Review Board of Hino Campus, Tokyo Metropolitan University (H21-046).

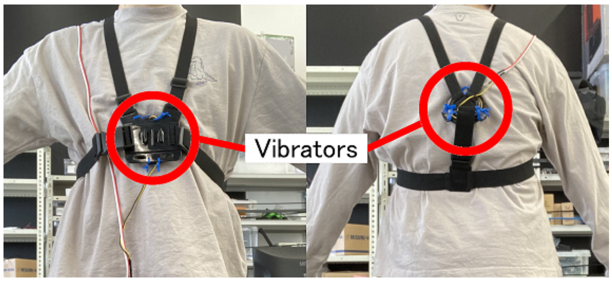

Fig. 1. Vibratory-stimuli vest. One voice-coil actuator each on the abdomen and back

A. Audio-visual contents (horror movies)

As audio-visual content, we used horror movies that included a jump-scare scene in which a monster or other horrific objects appeared suddenly accompanied by a loud sound to startle the viewer and scenes that suggest a succeeding jump-scare scene. In this study, we refer to the latter type of scenes as predictive scenes. Two movies perceived as approximately equally scary were used. Each video was approximately 1–2 min in length and is referred to as movie 1 and movie 2 in this paper.

B. Data recording equipment

The skin conductance of the hand was measured using AP-U030m II (Nihon Suntech, Japan) with an amplifier (MaPI720CA, Nihon Suntech, Japan). The outputs from the amplifier were recorded at 100 Hz using a data acquisition device (NI USB-6211, National Instrument Corp., TX) and controlled by the *Dara Acquisition Toolbox* of MATLAB (MATLAB 2021a, Mathworks, MA).

C. Vibratory stimuli

Two voice coil motors (Vp604, Acouve Lab., Japan) were used to generate vibration stimuli. As shown in Fig. 1, they were attached to the vest - one was in contact with the epigastric fossa and the other with T5 of the spine. Additionally, participants wore a corset over the vest to ensure close contact between the body and voice coil motors.

Vibratory stimuli were continually presented for 17 s during the predictive scenes. This period consisted of six units of vibration, each of which lasted 0.7 s. The frequency of the vibration was 70 Hz. The amplitude monotonically increased for 0.4 s from the start of the vibration and then monotonically decreased. The frequency and amplitude profiles were designed to match the predictive scenes by those familiar with vibratory stimuli, including the authors. The time between the last vibratory stimulus and jump-scare scene was approximately 15 s.

D. Measurement of skin conductance response

The skin conductance response of participants was measured as a physiological signal. The skin conductance changes due to sweating associated with tension and excitement and increases within 1–2 s after the onset of a stimulus, allowing the measurement of the arousal response to the instantaneous fear stimulus in the horror movie [7], [8]. Furthermore, the skin conductance reaches its peak in another 1—2 s. We calculated the difference between the resting level before the skin conductance started changing and the subsequent local peak amplitude.

E. Participants

We recruited eight university students (20 years or older, average: 22 years) who were unaware of the purpose of the experiment after obtaining written informed consent.

F. Tasks

Before the experiment began, the participants experienced vibratory stimuli thrice to familiarize themselves with the vibration. Participants then experienced audio-visual content with or without the vibration stimuli. The combination and order of the two movies and vibration conditions (with or without) were randomly determined for each participant. Before watching each movie, participants rested for at least 90 s. As a subjective evaluation, participants indicated the degree to which the jump-scare scene in the second movie was scarier than that in the first movie.

G. Analysis

We investigated the effect of vibration on skin conductance amplitude and subjective evaluation of fear. Multiple linear regression models with dummy variables were used to remove the differences in fear between the two movies. The model equation was

$$y = a_{\mathrm{vib}} x_{\mathrm{vib}} + a_{\mathrm{movie}} x_{\mathrm{movie}} + \mathrm{constant} \quad (1)$$

where y is the skin conductance amplitude or subjective fear value. The skin conductance amplitudes and subjective fear values were normalized to have an arithmetic and geometric mean of 1 within individual participants, respectively. x_{vib} is a binary variable representing the presence ($x_{\mathrm{vib}} = 1$) or absence ($x_{\mathrm{vib}} = 0$) of vibrations. x_{movie} is a binary variable representing the movie type. x_{movie} is 0 and 1 for movie 1 and movie 2, respectively. a_{vib} is the partial regression coefficient representing the effect of the vibration stimulus on y. a_{movie} is the partial regression coefficient for the effect of movie type. The a_{vib} and a_{movie} values were tested to determine whether they differed from 0. Two of the participants did not exhibit a variation in the skin conductance response to the vibratory stimuli and horror movies; hence, their skin conductance values were not included in the analysis.

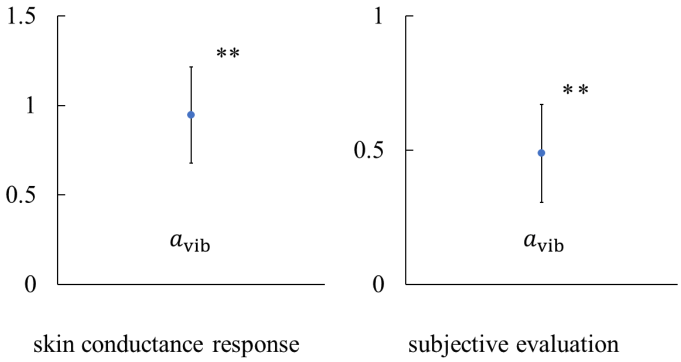

Fig. 2. Means and standard errors of a_{vib}, that is, the effect of vibratory stimuli. Left: Effect on skin conductance response Right: Effect on questionnaire

III. Results

The left and right parts of Fig. 2 show the values of a_{vib} for the skin conductance amplitude and subjective reports with standard errors, respectively. For skin conductance amplitudes, a_{vib} = 0.94 ($p = 0.003$). For subjective reports, a_{vib} = 0.48 ($p = 0.009$). Therefore, the vibration had a significant effect on the skin conductance amplitudes and subjective reports. Regarding the effects of the two movies, a_{movie} was -0.67 ($p = 0.018$) and -0.48 ($p = 0.011$) for skin conductance amplitude and subjective report, respectively, indicating that movie 2 felt more horrific than movie 1 to the participants.

IV. Conclusion

Vibratory stimuli to the upper body in scenes predicting jump-scare scenes increased viewers' horrific experiences as evidenced by subjective reports and physiological responses. Thus, conjunctive use of vibratory stimuli in predictive and jump-scare scenes is expected to further enhance the emotional experience of movies and horror games. In future, the effects observed in the present study should be studied in a large cohort.

References

[1] P. Lemmens, F. Crompvoets, D. Brokken, J. Van Den Eerenbeemd, and G.-J. de Vries, "A body-conforming tactile jacket to enrich movie viewing," in *Proceedings of IEEE World Haptics 2009-Third Joint EuroHaptics Conference and Symposium on Haptic Interfaces for Virtual Environment and Teleoperator Systems*. IEEE, 2009, pp. 7–12.

[2] G. Karafotias, A. Teranishi, G. Korres, F. Eyssel, S. Copti, and M. Eid, "Intensifying emotional reactions via tactile gestures in immersive films," *ACM Transactions on Multimedia Computing, Communications, and Applications*, vol. 13, no. 3, pp. 1–17, 2017.

[3] I. Tara, S. Okamoto, Y. Akiyama, and Y. Yamada, "Heightening fear response to horror video scenes by applying vibratory stimuli to upper bodies of viewers," in *Proceedings of IEEE Global Conference on Life Science and Technologies*, 2022, pp. 254–256.

[4] I. Tara, S. Okamoto, Y. Akiyama, and Y.Yamada, "How important is the timing of vibrotactile stimuli for the excitement feeling of audio-visual contents," in *Proceedings of IEEE Global Conference on Consumer Electronics*, 2021, pp. 183–185.

[5] C. Branje, F. Russo, G. Nespoli, and D. Fels, "The effect of vibrotactile stimulation on the emotional response to horror films," *Computers in Entertainment*, vol. 11, no. 1, p. 5, 2014.

[6] A. Damasio, "Feelings of emotion and the self," *Annals of the New York Academy of Sciences*, vol. 1001, no. 1, pp. 253–261, 2003.

[7] A. D. Craig, "How do you feel? Interoception: the sense of the physiological condition of the bod," *Nature Reviews Neuroscience*, vol. 3, no. 8, pp. 655–666, 2002.

[8] T. Makioka, S. Okamoto, and I. Tara, "Difference in skin conductance dynamics to horror and family bond emotional movies," in *Proceedings of IEEE Global Conference on Consumer Electronics*, 2022.