Facilitation of Affection by Tactile Feedback of False Heartbeat

Narihiro Nishimura
The University of Electro-Communications.
1-5-1 Choufugaoka.
Choufu-shi Tokyo Japan
n-nishimura@kaji-lab.jp

Shogo Fukushima
The University of Electro-Communications.
1-5-1 Choufugaoka.
Choufu-shi Tokyo Japan
shogo@kaji-lab.jp

Asuka Ishi
The University of Electro-Communications.
1-5-1 Choufugaoka.
Choufu-shi Tokyo Japan
asuka@kaji-lab.jp

Hiroyuki Kajimoto
The University of Electro-Communications.
1-5-1 Choufugaoka.
Choufu-shi Tokyo Japan
kajimoto@kaji-lab.jp

Michi Sato
The University of Electro-Communications.
1-5-1 Choufugaoka.
Choufu-shi Tokyo Japan
michi@kaji-lab.jp

CHI '12, May 5–10, 2012, Austin, TX, USA.
ACM 978-1-4503-1016-1/12/05.

Abstract
When a person is attracted to someone, characteristic physiological responses are observed, such as flush and perspiration. Our goal was to control this affective feeling by using artificial autonomous physiological reactions. To achieve this goal, we used vibration to simulate a heartbeat on subjects' chest with a voice-coil type actuator and controlled the frequency of the false heartbeat. In this study, we verify that the preference towards female nude photos was increased by modulating the frequency of the false heartbeat. We also discuss the suitable implementation of our method in applications such as movie viewing and daily communication.

Keywords
Emotional control; False heart-rate feedback; Tactile stimulation

ACM Classification Keywords
H.5.2. [Information interfaces and presentation]: User Interfaces - Haptic I/O;

General Terms
Human Factors

Introduction

Purpose of this research

When a person is attracted to someone, characteristic physiological responses are observed, such as flush and perspiration. These responses are autonomous reactions of the sympathetic nervous system that occur when a person experiences strong positive emotions toward the other [1].

Our goal was to accelerate or restrain this affective feeling by using artificial emotional reactions. Although the order of subjective emotional experiences and physiological reactions have not yet been determined, according to the James Lange theory, emotion is experienced as a result of physiological changes in the body induced by the autonomic nervous system [2]. Therefore, it is possible that presentation of a pseudo physical reaction may induce an emotional experience.

This technique may enrich audio-visual contents such as movies, by enhancing the viewers' affection toward characters, or it may build good relationships by face-to-face communication.

Heartbeat as a cue for affection control

Although numerous physiological responses are related to emotion, heartbeat is one of the most easy to implement and easy to understand cues. Some studies have shown that emotional experience and decision-making are affected when a false heartbeat is presented visually or aurally. Valins reported that the preference for semi-nude photos is influenced by modulating the frequency of a false heartbeat presented aurally and synchronized with the presentation of the photos [3]. The heartbeat sound has also been utilized in media art. In the *Empathetic heartbeat* [4] by Ando et al., viewers watch movies of nervous people while listening to their own heartbeat via headphones. As the volume of the heartbeat is increased, the viewers' empathy toward the nervous characters is increased. Nakamura et al. proposed a method for controlling heartbeat by displaying a false heart rate on a visual monitor. Individuals were instructed to look at the false heart rate while exercising on an aero-bike. The real heartbeats were found to be affected by the false information [5].

Proposal

Previous studies have shown that emotional or physiological state can be altered by presenting visual and auditory false heartbeats. In contrast, if these techniques are applied to audio-visual content such as movies and TV games, the audio and visual heartbeat cues may interfere and pollute the content itself.

We propose to present a false heartbeat using tactile cue, which do not interfere with audio-visual contents. Furthermore, the false heartbeat can be presented independently to each user, and common wearable or portable devices such as mobile phones and wrist watches can be utilized for heartbeat feedback, since these devices contain vibrators. Some previous studies have presented heartbeats using the tactile sense [6] [7], but the primary purpose of these trials was to support interpersonal communication, whereas our goal was to control affective feelings toward others by presenting pseudo information.

Experiment

We performed an experiment to verify that affective feelings toward others are altered by modulating tactile heartbeat cues. Specifically, we used female nude

photos and 8 healthy male participants, aged from 21 to 26 years.

The tactile device was attached to the left side of each participant's chest, and the device presented pseudo heartbeat vibrations. This position was selected because it is closest to the heart. The participants were told that the (pseudo) heartbeat vibration was a real-time replay of their recorded heartbeat.

The female nude photos were presented to the participants in random order, and the false heartbeat was increased, decreased, or kept constant. The participants were asked to evaluate the attractiveness of each photo using a 100-point scale.

Experimental system

TACTILE DEVICE

The tactile device was composed of an audio speaker (NSW2-326-8A: Aurasound CO.,LTD.) and microphone (WM-61A: Panasonic SC Device Solutions) (Figure 1). The speaker was connected to the headphone jack of a personal computer via an audio amplifier (RSDA202: RASTEME SYSTEMS CO.,LTD.). The microphone was a dummy, aimed at persuading the participants to believe that their heartbeat was actually being measured.

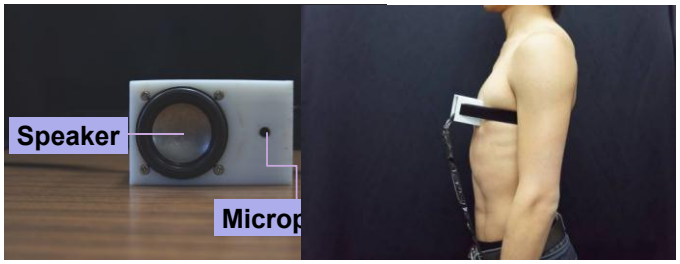

Figure 1. Left: Tactile device, Right: Tactile device attached to the left side of the chest

FREQUENCY CHANGE CONDITIONS

The actual voltage waveform of the audio speaker is shown in Figure 2, which represents the typical waveform of a heartbeat. We defined this waveform as 1 beat. The heartbeat frequency was modulated by changing the playback speed. Details of the frequency modulation are summarized in Table 1.

Visual stimuli were presented for 15 seconds each, with 60 second intervals. Vibration was presented to the chest at all times during the experiment; at the start of visual stimulation, 1 of 3 conditions, namely, "neutral," "increase," and "decrease," was randomly selected . During the intervals, the vibration of the neutral condition was presented. In the neutral condition, the frequency was randomly changed in the range of 66 bpm to 72 bpm every 5 seconds, and the frequency was set to specified values at the start of the visual stimulation. This value was 72bpm in the case of the increase condition and 66 bpm in the case of the decrease condition. An example is shown in Figure 3. Then, the frequency was linearly changed over 15 seconds. For the increase condition, the frequency was increased to 90 bpm, whereas or the decrease

condition, the frequency was decreased to 48 bpm. Then, over the next 15 seconds, the frequency was returned to the neutral condition.

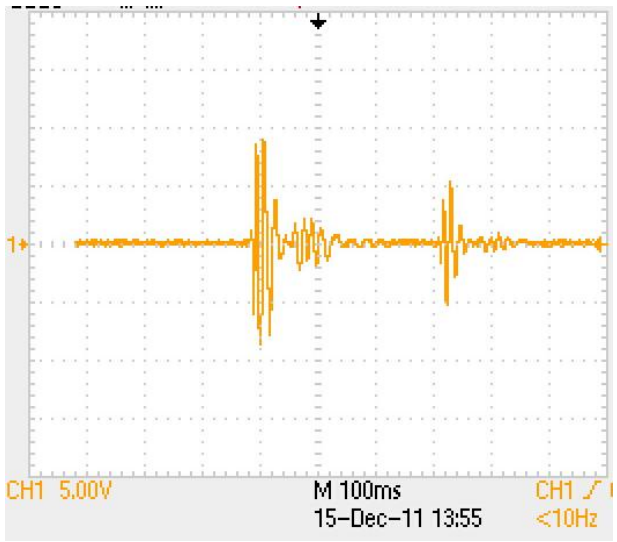

Figure 2. Actual output voltage from the audio speaker

Table 1. Details of the frequency changing of vibration

Condition	Change of heartbeat
increase	Change from 72 bpm to 90 bpm over 15 seconds
neutral	Change randomly between 66 and 72 bpm every 5 seconds
decrease	Change from 66 bpm to 48 bpm over 15 seconds

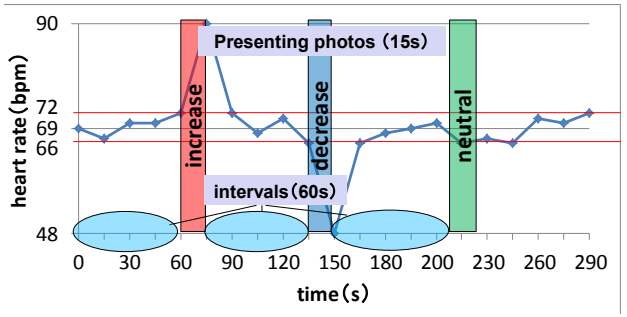

Figure 3. The relationship between the timing of presenting the visual stimulus and the change in the frequency of vibration

VISUAL STIMULI

Twelve female nude photos were used (PLAYBOY, Playboy Enterprise, Inc.). The photos were presented in random order. After each experiment, participants evaluated the attractiveness of the person in the photo using a 100-point scale (0points: not attractive at all, 100points: very attractive). Photos were presented for 15 seconds, and a black screen was presented for 60 seconds between photo presentations (Figure 4).

Figure 4. Overview of the experiment

Procedure
Participants were told that the experiment was being performed to examine how their heart rate would change when receiving feedback of their own heartbeat; they were also told that the presented vibrations were a replay of their own heartbeat recorded by the microphone.

The device was attached to the skin on the left side of the chest, and the participants adjusted the volume of the amplifier so that they could slightly perceive the tactile stimulus (tactile threshold). In the main experiment, the volume was doubled. In the first 60 seconds, only vibration was presented to allow the participants to adapt to the tactile stimuli. Then, visual stimuli were displayed and 1 of 3 frequency-modulated vibrations was presented for 15 seconds. After the presentation, the visual screen turned black and the neutral vibration was presented for 60 seconds. The participants repeated this trial 12 times with 12 different pictures and were then asked to fill in the questionnaire. After a 3-minute break, the same 12 trials and questionnaire were repeated in a different order. A white noise was played in the background throughout the experiment so that the participants could not perceive the tactile stimulation via the audio modality.

Result
The results are shown in Figure 5. Since 1 participant noticed that the presented vibration was not synchronized with his own heartbeat, this participant's data were removed from the results. The vertical axis shows the average attractiveness score of the photos, and the horizontal axis shows the different conditions. The average score in the decrease, increase, and neutral conditions was 61.9, 71.6, and 61.5 points, respectively. ANOVA revealed a statistically significant difference between conditions ($F_{(2,153)}=3.06$, $p<0.01$).

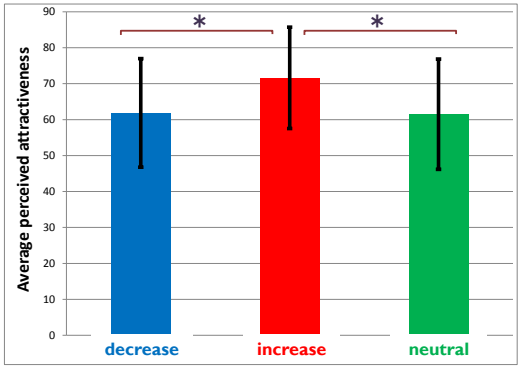

Figure 5. Results of the experiment

Discussion
As we expected, when the false heartbeat rate was increased, the perceived attractiveness of the photo was increased.

After the experiment, some participants commented that their excitements was increased when their feelings and the vibration frequency were matched, whereas they felt unpleasant when they were not matched. This finding indicates that our method can "enhance" the feeling, but cannot "alter" it.

On the other hand, contrary to our speculation that a decreased false heartbeat rate would negatively influence attractiveness, the score in the decrease condition was the same as that in the neutral condition. Some participants commented that they felt

comfortable when the decreased vibration was presented, which may explain this result.

Conclusion and Future Applications

In this study, we have verified that the affective feeling towards others can be controlled by presenting a pseudo heartbeat as tactile stimulus. There were 2 important findings. One is that the affective feeling can be enhanced by presenting a faster heartbeat, and the other is that the tactile stimulus cannot alter the feeling from bad to good.

The device used in the experiment has to be placed around the trunk to be fixed on the chest and is therefore not suitable for practical use. We need to embed the device in daily commodities.

When a cushion is lying on a sofa or chair, we naturally tend to hold it (Figure 6, left). We have utilized this natural reaction to develop a new device. A voice-coil type actuator is embedded in a cushion, which then presents a vibration to the chest when it is held. On the other hand, we occasionally place mobile phones in our chest pockets. Therefore, it is quite reasonable to use vibrators in mobile phones or embed voice-coil vibrators in phones for better vibration quality (Figure 6, right). The next step is the development and evaluation of these 2 prototypes.

Figure 6. Two natural implementations of the heartbeat display. Left: The vibrator is embedded in a cushion. Right: The use of the vibration condition of a mobile phone in a chest pocket

References

[1] Bear, M.F, Connors, B.W, and Paradiso, M.A, "*Neuroscience*". Lippincott Williams & Wilikins, 15 (2007), 488.

[2] What is emotion? , *Mind 9* (1884), 188-255.

[3] Valins, S. Cognitive effects of false heart-rate feedback, *Journal of Personality and Social Psychology 4*, 4(1966), 400-408.

[4] Ando,H., Watanabe, J., and Sato, M., Empathetic heartbeat. http://www.junji.org/

[5] Nakamura, K., Katayama, K., Terada, T., and Tsukamoto, M., Evaluation on effect of presenting false information for biological information visualization systems, *IPSJ SIG Technical Report 2011-UBI-30*, 1(2011) (In Japanese)

[6] Werner, J., Wettach, R., and Hornecker, E. United-Pulse: Feeling Your Partner's Pulse, *MobileHCI'08*, 2008, 535-538.

[7] Mcdaniel, T., Villanueva, D., Krishna, S., Colbry, D., and Panchanathan, S., Heartbeats: A methodology to convey interpersonal distance through touch, *CHI 2010: Work-in-Progress,* 2010, 3985-3990.