Basic Study of Evoking Emotion Through Extending One's Body Image by Integration of Internal Sense and External Sense

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Abstract. Emotion has closely relationship with one's body image. In some cases, external object that physically separates from body is recognized as one's body image. In other words, the body image extends to the external object. This phenomenon happens by integration of internal sense that perceives one's body and external sense that perceives the outside of the body. On the other hand, the type of evoked emotion is decided from cognizing not only body image but also attribution of causality. General approaches to evoke emotion in recent have not discussed the causal attribution in depth. This study has proposed a new method for evoking emotions through touching upon the discussion of causal attribution. To investigate the feasibility of our approach, we made "Interactonia Balloon" that lets users evoke a tense feeling by coupling and decoupling a change in respiratory condition and a movement of a balloon. In this paper, we report on the feedback and implications obtained through the exhibition of this work.

Keywords: Interaction design · Multimodal interaction · Evoking emotion · Body image · Somatopsychology

1 Introduction

Emotion has a closely relationship with body perception. In the field of psychology and cognitive science, there have been discussed that either emotion or physiological changes in earlier. Generally, it is considered that emotion evokes by recognizing outside world and physiological changes occurs as the result of the change in the emotion, such as heart rate and facial expression. However, theories that claim body perception changes prior to change in emotion are met with acceptance recently [1, 2]. Besides, it is clarified that an awareness of physiological changes evokes emotion even if real physiological changes does not occur [3]. In other words, emotion evokes depending on not real bodily condition but an imaginary one's body condition.

In recent years, there have been some studies to evoke a specific emotion by presenting external stimuli that is felt as if own body changes based on the above-mentioned findings [4–7]. These methods can evoke emotion without interpreting meaning of presented stimuli. Nevertheless, these have a problem that it is difficult to evoke emotion when the presented stimuli are not felt like own physiological changes.

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Moreover, it is required to be recognized not only physiological changes but also the reason why the physiological changes occur [2]. The recognized the reason is called "attribution of causality," which determines the type of emotion experienced. Many of existing studies for evoking emotion try to evoke emotion by changing presented stimulation depending on the context of surrounding environment. However, it is difficult to evoke specific emotion at aimed timing when the change of the recognized stimuli is not attributed to aimed emotion.

On the other hand, emotion changes by through volantary activity. This reason is considered that the attribution of causality of the physiologial changes switchs from individual own will to other factors when human move own body intentionally. We hypothesis that emotion also evokes by leading a person to move his/her body actively in a specific way, and swich the recognized attribution of causality of tha change in the body from his/her will to other elements in midstream.

The authors focus on a phenomenon that an external object is recognized as a part of body through intentional controlling of the object. The phenomenon happens when the internal sense that perceives a own body and the external sense that perceives the controlled object are perceived as synchronized temporally and spatially. The external object recognized as a part of body is described as "extended body" in other words.

In this study, we propose a method for evoking emotion by giving recognition to the external object as the extended body through intentional controlling the object using their body in a specific way, and swithcing the attribution of cousality of the extended body's change from the volantary activity to other outside factor.

To investigating the feasibility of such an approach, the current study focused on using respiration as a physical response that relates to emotion. For instance, respiration is closely related to a tense feeling, and respiration can be changed both automatically and intentionally. The current study also proposes an interactive apparatus named "Interactonia Balloon", which evokes and enhances tense feelings by switching an attribution of causality of the choking feeling. In this paper, we first explain the concept and design of the Interactonia balloon. We also describe participants' reactions and feedback on using the apparatus.

2 Emotion and Body Image

2.1 Emotion

Emotion is used as a term for relational mental phenomenon. What is the emotion called differs depending on the mental condition. Sometimes, "affect" and "mood" are used as equivalent terms with "emotion." "Affect" refers to externally displaying of emotion, such as facial, vocal, or gestural means [8]. "Mood," as represented along a "positive/negative" or "pleasant/unpleasant" dimension, refers to a more long-term mind-set that changes gradually [8]. Furthermore, mood responses are not as strong as would be expected when referring.

For the current study, we treated "emotion" as comprising three psychological states: "emotion," "affect," and "mood." We defined emotion as, "subjective experiences and actions, which are caused by changes in bodily responses, including facial expressions and physiological reactions."

2.2 Emotion and Body Perception

In the field of cognitive science, numerous researchers argue that changes in bodily and physiological responses can unconsciously evoke an emotion. The basis for these theories is the James-Lange theory [1]. James aptly expressed this phenomenon: “We don’t laugh because we’re happy - we’re happy because we laugh.” Many studies verify the theory. For example, the facial feedback hypothesis indicates that changes in facial expressions affect emotional experience: smiling enhances pleasant feelings while diminishing unpleasant feelings [9]. Many works based on the James-Lange theory demonstrate that changes in physiological states affect feelings. For example, a pleasant feeling is evoked by smiling and by only seeing smiley faces [10]. Facial expression has greatly effect on what emotion evokes regardless of the facial expression is created consciously or unconsciously [11]. This indicates that the unconscious physiological change in the motion of muscles evokes a specific emotion. As other example, Valins et al. shows that cognition of false heart rate affects how participants are attracted to a woman in a picture [12].

There are some engineering studies for evoking emotion by making a user feel like own body changes. For instance, Fukushima et al. proposed an interface that tries to enhance a “chilly” feeling by reproducing a feeling that raises body hair while watching a movie that induces surprise [4]. Yoshida et al. showed that having to recognize minute computer-generated facial changes could evoke pleasant or unpleasant feelings and suggests the possibility that evoked feelings influences a user’s preferences [5]. Sakurai et al. propose methods to evoke plural emotions using some tactile stimuli that have a huge similarity to various physiological changes [6, 7].

On the other hand, the two-factor theory of emotion, advocated by Schachter et al., states that changes in bodily responses can be related to several emotions; thus, discreet emotions cannot be completely determined by changes in bodily responses [2]. Recognizing changes in bodily responses, such as nervousness, sedation, raised heart rate, elevated blood pressure, or tremors, referred to as the “attribution of causality,” determines the type of emotion experienced. Therefore, different emotions would evoked according to how people interpret their own environments, including situations when similar circumstances and bodily responses arise [13].

General approaches used in previous studies mainly try to evoke emotion by changing body image through generating and regulating virtual physiological changes. Using these methods, it is required to provide extraneous sensory stimuli that resemble bodily responses without discomfort. It would be a problem if these stimuli do not mimic changes that would occur in one’s body, as the aimed emotions will not be evoked. In addition, when trying to evoke the aimed emotion by varying the presented stimulus, there are two key issues: the change in physiological state is not recognized, or the change in state is recognized, but is not attributed to the target emotion. This can make it difficult to definitively evoke an emotion.

In response to previous studies, our approach lets the cause of a physiological change attribute in intentional movement (arising of a sense of ownership) firstly. This has persons clearly perceive that the attribution of causality of the physiological change shifts from the intentional movement to aimed emotion as a side effect of unconscious change of external situation that is not intended (switching attribution of causality). Our approach addresses the ambiguity of the causal attribution by replacing the attribution.

2.3 Body Image Construction via Integration of Internal and External Senses

What an emotion evokes is determined based on perceived body image, which is not necessarily the same as real bodily condition. The body image is constructed depending on how various senses integrate. The internal senses are to know own body. These include visceral and somatic sensations (i.e. deep and cutaneous senses.) The body that is perceived through the internal senses based on somatic sensory is the representation of the physical position that is referred to as “body schema” [14, 15]. On the other hand, the representation of the body is not always perceived based on only body schema. For example, to grasp the position or movement of viscera and muscles is very difficult even if we know these organs exist inside own body. In order to infer such physical condition, external senses complements the internal senses. The external senses are specific senses to perceive outside of body, which includes visual and auditory sensations. For instance, although we cannot grasp own face or back directly, we can grasp these body sites. The representation of own body, which is perceived subjectively, is termed “body image” by combination of internal and external senses [15].

The body image is free from physically restriction. What is not actual body is sometimes contained in the body image [16, 17]. Conversely, actual body is not perceived as own body in some cases [18]. The scope that is perceived as own body is determined depending on senses of ownership and agency [19]. The sense of ownership is a feeling that the thing belongs own body, for example “This is my body.” The sense of agency is a feeling that the agent of action is one’s owns self, for example “I manipulate this.” The thing that is not actual body is perceived as a part of own body when these senses arise in the thing. It is clarified that synchronization of the internal senses that perceive own physiological changes and external senses that perceive the changes of outside of body arise senses of ownership and agency in the external thing temporally and spatially without a feeling of strangeness [16].

Using the finding, we propose a method for evoking a specific emotion by giving recognition of a change in an extended body as the causal attribution of actual specific physiological change after giving perception of the external object as a part of own body. Our approach utilizes bodily responses that change both passively and actively. In our approach, firstly, a system constructed that actual physiological condition fed back to the situation of outside of body. This system makes a person understand intentional controlling the physiological condition alter the outside of body. At this time, the physiological change is attributed to one’s intentional action, and senses of ownership and agency arise in the outside of body. After this, the correspondence between the physiological condition and the situation of the outside of body is altered at aimed timing for evoking the emotion. This alternation of the correspondence makes the person feel like controlling the situation of outside of body is difficult though s/he has controlled the outside of body. When the emotion is to be evoked, this feedback system variegates the correspondence between the physiological change and the situation of outside of body. This change in the correspondence makes it hard to control one's own bodily response (in this case, respiration), even if the individual feels s/he can control respiration at will. Since this cognitive change gives rise to a recognition that the physiological change occurs due to active or passive action, the feedback system makes the user aware of the possibility that the cause for the change in bodily response was altered (replacing the causal attribution) (Fig. 1).

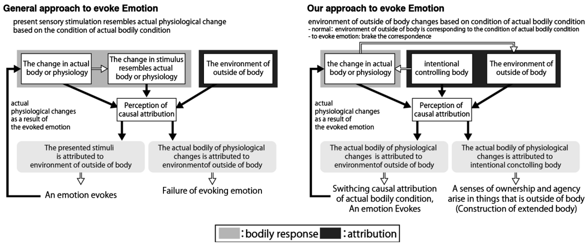

Fig. 1 General approach of previous studies and our approach (created based on [2])

The main difference between previous studies and our approach is whether causal attribution is considered. A sense of discomfort within a sensory stimuli resemble physiological changes have become a problem, since approaches from previous studies needed to provide sensory stimuli passively to evoke changes in actual physiological changes. However, our approach can solve problem of such an uncomfortable feeling, since our approach forms a process of inferring the conscious control of a physiological change. A loss of a sense of ownership and agency creates an unconscious change in physiological changes both actively and passively.

Considering causal attribution in this process for evoking emotion, our approach also could the target emotion at specify timing. This is because the time needed to replace the causal attribution can adapt to the adjustment of the time required to alter the correspondence between the bodily condition and the situation of outside of body.

In this paper, we focused on respiration as a consciously controllable physiological changes and a tense feeling as the emotional response related to respiration. This method evokes a tense feeling by alternating the correspondence between the intentionally controlled respiratory phase and changes in the external condition associated with respiration.

3 Evoking Emotion by Extending Body Image

In order to investigate feasibility of a method for evoking emotion by switching causal attribution, we make an interactive device named "Interactonia Balloon." This apparatus evokes and enhances the tense feeling by shift the perceived causal attribution of respiratory phase using a balloon (Fig. 2). In this section, we describe the Interactonia Balloon's design.

Fig. 2 Interactonia balloon

3.1 Definition of the Feeling of Tension from Respiratory Condition

A tense feeling is an emotion defined as a psychological state that braces for a motivated action [20]. The tense feeling results in some physiological changes such as sudation, dry throat, elevated heart rate, and changes in respiration [21]. Sudation, dry throat, heart rate cannot be consciously controlled, since they are automatic physiological response. Conversely, respiration can be both an automatic and volitional physiological reaction. Respiration is also interrelated mutually with psychological and physiological phenomenon. Some emotions can be elicited by changes in breathing rate, and certain emotions can influence the rate of respiration.

The tense feelings have a close relationship with respiration [22, 23]. Tense feelings can cause shallow and rapid breathing or the cessation of breathing in extreme circumstances. Thus, unconscious breathing can evoke tense feelings depending on how an individual evaluates the situation they find themselves in.

3.2 System Design

Evoking a Tense Feeling by Controlling Respiration. Since a tense feeling tension can be rephrased as a smothering feeling, having trouble breathing could easily become a way to evoke tension. The Interactonia Balloon lets a person recognized a balloon as his/her own extended body through consciously controlling respiration firstly. Next, the apparatus alter the movement of a balloon in midstream for leading a tense feeling to evoke when suffocation feeling is brought to the person due to the controlling breathing. Following through with these steps, the attribution of causality of the smothering feeling switches from consciously controlling respiration to unconscious change of the extended body and a tense feeling evokes.

Interaction Design for Evoking a Tense Feeling. This apparatus utilizes a balloon in order to interact in order to evoke a tense feeling. The balloon has two functions: One of the functions is inducing consciousness of controlling respiration actively. The first thought that comes to mind for inflating a balloon is to breathe into the balloon. Based on this expectation, the balloon acts as a reminder that respiration is actively involved in the process.

Another function is an extended body of the user for evoking a tense feeling by creating a sense of ownership in the balloon. The action of the balloon corresponding to respiration is paradoxical. The user can inflate the balloon by intentionally controlling his/her own respiration, if this correspondence is understood. In this situation, labored breathing attributed to the user's conscious. Besides, the senses of ownership and agency arise in the balloon, if the user understands the correspondence between respiration condition and the movement of the balloon and how control the balloon as intended. Conversely, when the balloon keeps inflating, the correspondence changes because it becomes difficult to get air out of the balloon if the user holds his/her breath. This change in the correspondence switches the perception that the user is controlling the balloon, producing the perception that the balloon controls the user. Then, there is paradoxical movement of the balloon resulting in impatience about not being able to inflate the balloon, and the potential for breaking the balloon. This obscures the correspondence between the respiratory phase and the balloon. This leads to an increased feeling that the user cannot control the balloon. This change in causal attribution is recognized, and the balloon evokes and enhances a tense feeling (Fig. 3).

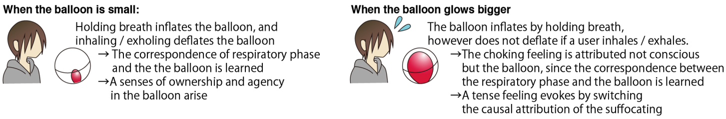

Fig. 3 Interaction design of interactonia balloon for evoking tense feeling

3.3 System Configuration

Figure 4 shows the system configuration of the interactonia balloon. This system of consists of a respiration detection unit, an air control unit, and an output unit. The respiratory detection unit (Fig. 5) put under the nose detects a user's respiration. To detect respiration, we use a method that employs a temperature sensor in reference [24] to the system used in. When a user exhales through the nose, temperature increases because the air heated by the body that is blown out through the nose flows into the detection unit. In contrast, when the user inhales through the nose, the temperature in the detection unit decreases because the air within the room is cool as it flows into the detection unit. However, holding one's breath keeps the temperature within the device constant since the air in the detection unit does not transfer.

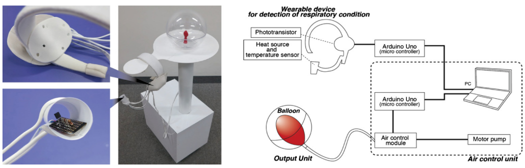

Fig. 4 System configuration

In order to amplify the change in temperature around the temperature sensor within this unit, resistors are placed on the device between the temperature sensor and the user's nose. The heat created by electric current from the resistors is utilized as a heater. If temperature change in a given period is greater than a certain level, the system deems

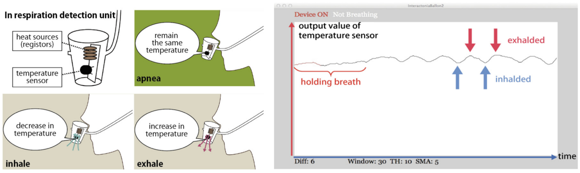

Fig. 5 Respiration detection method and obtained respirogram using the method

that a person is either exhaling or inhaling. In contrast, if the change is less than a certain level, the system deems that the person is holding their breath. Figure 5 shows the respiration curve that illustrates the above-mentioned method for detecting respiration.

A photo-interrupter is attached to the internal left temporal region of the wearable device in order to detect whether the device is actually being worn. When the device is being worn, a motor pump in the air control unit turns on. Conversely, when the device is not being worn, the motor pump turns off, and the air comes out of the balloon. The output unit consists of a balloon and a plastic capsule covering the balloon. The air control unit controls an air pump to inflate or deflate a balloon within an output unit based on the respiratory condition. A pump forces air into the balloon within an output unit and lets the balloon grow bigger when the wearable device is worn, detecting that breath is being held. In contrast, when the pump stops, the air flows back into the air tube, and the balloon deflates when inhalation is detected.

4 Investigation of a Method for Evoking Emotion by Switching an Attribution of Causality of Changing in Extended Body

4.1 Feedback Given Regarding Interactonia Balloon at an Exhibition

We exhibited the Interactonia Balloon at Siggraph Asia 2012, held in Singapore, from November 28 to December 1 2012 (Fig. 6.) During the exhibition, over 100 people visited the exhibit.

Fig. 6 Exhibiting the interactonia balloon at siggraph Asia 2012

Most visitors were told how to inflate the balloon before the exhibition. We had visitors wear the device and breathe normally. After visitors verified whether breathing was detected in a normal way, we had them play with the balloon. After a visitor was done with the demonstration, we explained the concept of this apparatus, regardless of whether they could inflate the balloon or not. If we did not explain how to play with the balloon, several people tried to inflate the balloon by exhaling.

Feedback about the apparatus can be classified into three major categories: (1) visitors felt tension, (2) visitors did not feel the tension, and (3) visitors could not work the balloon. Detailed feedback is mentioned below.

Group 1: Visitors Who Could Feel Tension. We obtained the following feedback from participants who said they felt tension.

- I surely felt tension when I kept holding my breath and the balloon kept inflating.
- It was a little bit scary, since I could not understand why the balloon inflated when I held my breath, even though this was explained to me beforehand.
- When the capsule was filled with the balloon, I felt tense and impatient, and my breathing was disordered.
- I was relieved when the balloon deflated.
- We control our own breathing to be released from a tense feeling, in most cases. However, the balloon requires that we breathe to bring about a tense feeling. This is interesting.

There were several cases where other visitors watched a person playing with the balloon. The onlookers remarked as follows:

- I felt tension, too.
- Watching others play made me feel tense.
- I could not understand what was happening by just observing.

Thus, the visitors felt tension and made remarks related to the paradoxical action of the balloon becoming the cause for evoking a tense feeling.
These visitors also laughed after playing with the balloon, regardless of whether they played or watched and whether they were acquainted or not.

Group 2: Visitors Who Did Not Feel Tense. We obtained the following feedback from visitors who said they did not feel tense.

- The inflation of the balloon did not cause me to feel any tension.
- Just merely controlling my breathing did not cause me to feel tension.
- I felt tension not by operating the balloon but by watching others playing with the balloon.
- There was a lack of tension because the exhibition hall was noisy.
- I did not feel that the balloon synchronized with my respiration.

Based on this feedback, the inflation of the balloon did not appear to facilitate tense feelings among these individuals.

Group 3: Visitors Who Could Not Operate the System. Some visitors could not inflate the balloon. They made the following remarks:

- I thought that the balloon was not working because my respiration decreased.
- I regret that the balloon did not work as I expected.

There were special cases were people gave up if they could not understand the timing of changes to the balloon and respiration after several seconds.

4.2 Discussion

Participants belonging to Group 1 remarked that tense feelings were evoked by a synergistic influence of intentionally controlling their breathing and changes to the balloon. In contrast, participants belonging to Group 2 remarked that they did not understand that their respiration and changes to the balloon were related. Additionally, their feedback suggested that the surrounding environment influenced their causal attribution to a greater degree than changes to the balloon. It appears that tense feelings were evoked by activity from the balloon "controlling" their own breathing.

As concerns the laughing of all participants belonging to Group 1 persons watched the experience of the participants after playing with the balloon, we postulated that their laughter was a way to relax the tension Thus, it is possible that laughter was brought about once the evoked physical tension had been reduced. Kant said, "laughter is an affection arising from a strained expectation being suddenly reduced to nothing" [25]. Based on this theory, we hypothesized that an evoked tense feeling due to actively controlling respiration reaches a certain threshold, and laughter is brought about once an individual is free from that evoked tense feeling.

We observed that holding one's breath and inflating the balloon caused visitors in Group 1 to feel tension, even if they knew that the apparatus worked in this way. This indicates that inflation of the balloon fulfilled its function of replacing the causal attribution related to evoking a tense feeling. The balloon facilitated a paradoxical outcome whereby the balloon performed a certain function that caused visitors to feel a loss of autonomous control.

Some participants could not manipulate the balloon as we intended. It is possible that these individuals had a problem in accurately detecting their own respiration. The temperature of the air conditioner in the exhibition venue was very low, and air current within the venue was variable. Therefore, even though these individuals held their own breath, it was difficult to detect changes in airflow. Besides, there were some cases where the variation of an individual's breathing habits prevented detection of respiration (e.g., breathing stops for a second when switching between inhalation and exhalation). In these cases, the respiratory phase was not correctly detected. It is possible that such false detections made it difficult for some participants to correctly experience the apparatus. One way to solve this issue would be to assess any potential technical problems. However, it could just be the case that these individuals did not find value in the demonstration. Participants belonging to Group 3 finished playing with the balloon in less than a minute, whereas people from Groups 1 and 2 played with the balloon for at least 5-10 min. These results suggest that in order to maintain a participant's attention with this demonstration, synchronization needs to happen rapidly (i.e., in first several seconds).

Based on the aforementioned results, we suggest that a tense feeling was evoked among participants due to the following: (1) a loss of a sense of belonging to one's own self, (2) the cause of changes to one's own bodily response was attributed to changes in the external environment, and (3) after being able to control their own bodily response, the participants felt that they could manipulate the external situation. However, the paradoxical actions of the balloon made participants lose a sense of belonging to their own self, and differences in individual recognition were not presently investigated. Therefore, further studies are needed to validate this measure in a more experimental setting, in order to examine how changing the external condition is associated with changes in bodily responses.

5 Conclusion

In this paper, we proposed a method for evoking and enhanced emotion by switching attribution of causality of a specific physiological change through giving perception of extended body. Concretely, we made an apparatus that evokes a tense feeling by shift causal attribution of respiratory condition from conscious controlling to movement of balloon. Feedback from participants who played with the apparatus suggested a need to create a training regimen that allows a user to feel like they are manipulating the external situation by controlling their own bodily reactions. For this, a feeling of loss of control and attribution of changes to bodily responses to external conditions for emotion evocation is warranted.

Based on these results, we will examine how changing an external condition associated with changing a bodily response replaces a sense of actions belonging to one's own self to influence emotion evocation in a more controlled experimental setting. To better explain the process of evoking emotions through the validation of our proposed method, we need to understand the interactive components of the apparatus and the types of bodily responses elicited. The results of the current paper suggest a feasible way for switching causal attributions by altering the correspondence between variability in physiological changes and a condition of outside of body. Conversely, understanding how to alter causal attributions is not yet fully understood. Future studies will need to better assess methods for evoking emotion aimed at the timing needed to replace causal attributions.

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