Breath Chair: Reduce Fear and Anxiety by Simulating Breathing Movements

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Abstract. In this paper, we proposed the concept to alleviate fear or anxiety by reproducing the sensation of being with someone and developed Breath Chair. This system is the chair and the polyurethane sponge built into the backrest can reproduce the sensation of a human breathing by repeatedly evacuating the air and contracting similarly to a human chest during breathing. We evaluated our proposed system using two films as eliciting stimuli for emotion of fear or anxiety; fear levels or anxiety levels the experiment were examined using State-Trait Anxiety Inventory (STAI), heart rate and fingertip temperature. STAI was used before and after the viewing of films. Heart rate and fingertip temperature were measured throughout the viewing of the films. Score of STAI and heart rate were no significant difference. Fingertip temperature were higher with simulated breathing than without, revealing a significant difference. There was significant difference. These evaluation results suggested that subjects' fear or anxiety decreased as a result of simulating breathing.

Keywords: Substitute robot · Simulating breathing · Fear · Anxiety

1 Introduction

While fear and anxiety are emotions that function as a self-defence mechanism by preparing a person to fight back against or escape from a threat, they may also cause neurotic disorders (also referred to as depression or anxiety disorders) when experienced to an excessive degree. The estimated number of patients with depression and similar disorders in Japan was 112,000 in 2014, and the estimated number of patients with neurotic disorders and the like was 59,000. These estimated numbers have been on the rise since 1996 [1]. Furthermore, approximately 67% of Japanese people experience worry and/or anxiety in their daily lives [2]. Therefore, we developed the Breath Chair as a system to alleviate emotions such as fear and anxiety (Fig. 1).

Physical contact has been cited as a method of reducing fear and anxiety. Physical contact triggers the secretion of oxytocin, which has been reported to act to suppress anxiety [3]. Therefore, being around others and engaging in physical contact could reduce fear and anxiety. An experiment by Gergen et al. [4] examined people's reactions to being in a well-lit room and to being in a pitch-dark room, which was speculated to

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induce fear. In this experiment, approximately 90% of subjects intentionally made physical contact with other people in the pitch-dark room despite it being their first meeting with these other people, and approximately 50% reportedly hugged each other. Furthermore, Gergen et al. reported seeing no physical contact or hugging in the well-lit room. These findings suggest that physical contact is a means of alleviating fear and anxiety. Moreover, the other person with whom you make physical contact does not need to be a specific person, such as a close friend, lover or family member. This is because even physical contact with an "unspecified" person is thought to alleviate fear and anxiety. However, even if physical contact with an unspecified person is successful in reducing fear and anxiety, intimacy between the people making physical contact is considered deeply related to the inherent act of physical contact in humans—with the exception of specific environments such as darkness. Hall [5] categorises inter-personal distance into close distance, personal distance, social distance and public distance and describes how the physical distance between people communicating with each other is proportional to the psychological distance. This suggests that physical contact between people is an act that is difficult to establish, with the exception of specific people with whom we have a close relationship, such as friends, lovers and family members.

Fig. 1. Using Breath Chair

However, the environment in Japan has recently been changing into one where it is difficult to initiate physical contact in daily life, even with specific people with whom one may have a close relationship. The rise in the percentage of unmarried people is leading to reduced proportions of people living together with a spouse or child [6]. Moreover, the proportion of single-person households has been increasing year on year, reaching 27.1% in 2014 and accounting for more than a fourth of all households [7]. These circumstances may also be reducing the opportunities for physical contact with spouses and children, with whom people have close relationships. Thus, initiating physical contact in daily life is now becoming more difficult. We therefore developed a system that simulates the feeling of physical contact by using a substitute for actual physical contact to reduce fear and anxiety. We then examined the effects of the

simulated physical contact of this developed system, which evokes the presence of an unspecified "someone," on fear and anxiety.

2 Related Work

2.1 Classification of Emotional Behavior

With regard to the workings and mechanism of the human heart, Ekman [8] identified the features of basic human emotions as being suggestive universal signals, and emotions as having a specific physiological state, starting in a short time, lasting only a short time and occurring spontaneously. Based on these features, and from the perspective of facial expressions, emotional behavior can be classified into the six types known as happiness, fear, disgust, anger, sadness, and surprise.

Further, May [9], in regard to the relationship between types of anxiety and fear, described fear as a response to a clear threat, while anxiety, on the other hand, is not clear, and is rather a vague response to an unspecified threat.

In this study, we link this to physiological state, and based on Ekman's classification of basic emotions, deal with the human behavior of fear, among others. Furthermore, we handle anxiety as human behavior similar to fear.

2.2 Verbal Information and Non-verbal Information

Kurokawa [10], in regard to communication, defined messages as information that humans could read, regardless of whether such messages are transmitted consciously or unconsciously. He further defined the transmission of messages using "words" as verbal, and messages transmitted using means other than "words" as non-verbal. Examples of non-verbal information include not only bodily gestures and hand gestures, but may also refer to tone of voice, skin color, clothing, sneezing and yawning.

Non-verbal information is considered to greatly impact the smoothness of communication. Watanabe et al. [11, 12] reported that the ON-OFF of the speaker's voice and breathing, in relation to the phenomenon of the listener retracting their breathing, plays an important role in smooth communication. This is not only the case for adults, and tests involving infants and their mothers show that this retraction phenomenon also exists in communication during the early stages of development. They reported that this non-verbal interaction is an essential form of communication in human biology.

In this way, not only bodily gestures or hand gestures, but the message qualities possessed by physiological non-verbal information are also considered to be important, and there are many studies dealing with physiological non-verbal information. For "glowworm communications" by Kizuka et al. [13], the rhythm of exhaling and inhaling in the user's breathing is visualized by LEDs by changing the color. This envisages use between two persons, and breathing and transmission of messages with those changes acts as an aid to communication. Furthermore, in the "Lovable Couch" by Iwamoto et al. [14], presentation of the heartbeat is seen as information with which to judge the friendliness brought by their communication partner when men and women are meeting for the first time. Presentation of the heartbeat is a factor in judging the friendliness brought

by one's communication partner, and a positive correlation between actual friendliness and heartbeat information has also been derived through experiments. Based on these results, this is an aid in judging the friendliness brought by a member of the opposite sex and communication.

As shown by the aforementioned examples, thus far there have been studies on aids to communication and the impact on emotional behavior using the presentation of non-verbal information, such as breathing and heartbeat and changes in the same. However, there have been few studies dealing with the continuous transmission of fixed physiological information in a restful state during normal times.

Therefore, as the objective of this paper, rather than dealing with variable physiological non-verbal information and its messages, we have studied the impact on emotional behavior of simply being with "someone", through the continuous presentation of fixed physiological information. We focus on breathing as one of the physiologically essential forms of communication from the study by Watanabe et al. [11, 12], and propose the movement of the chest during human breathing as an element artificially providing the sensation of bodily contact. We have developed a system that aims to relieve fear and anxiety by artificially providing the sensation of bodily con-tact through chest movement during fixed human breathing in a restful state.

2.3 Robots as an Alternative to Living Things and the Reduction of Anxiety

Thus far, studies using robots as alternatives for living things have been actively conducted. Among these studies, the seal-like robot "Paro" by Shibata et al. [15] has been used as an alternative to animal therapy in welfare facilities. Furthermore, in experiments in robot therapy carried out in pediatric hospital wards, positive results have been achieved using Paro to improve mood and to alleviate anxiety when children are away from their parents.

There have also been studies conducted on the materials and mechanisms of robots and soft toys, including research on the use of soft materials with the aim of preventing damage to devices and user injury that may result from this [16]. Additionally, Takase et al. [17] used soft materials from the perspective not only of damage and resulting accidents, but from the perspective that the feeling of hardness to touch in contrast to the external appearance of the soft toy robot may induce a feeling of unease in the user, and become a factor creating a sense of distance in the user's interaction with the robot.

We have developed a doll-type system in which, through the expansion and contraction of a balloon using air, we artificially present the movements of the chest when living creatures breathe [18]. However, whereas a balloon can be said to have the advantage that it is soft, on the one hand, because it is a highly elastic body, there is the problem that it can warp greatly when external pressure is applied. Due to this highly elastic quality, it is difficult for the balloon to maintain the core of the doll, or an unnatural warping sensation is given to the user from the external appearance of the doll. Furthermore, there is also the risk of damage or rupturing caused by children handing the blown-up balloon in a rough way. Based on this, therefore, we proposed, as the mechanism of this system for presenting chest movement at the time of human breathing, not a balloon

swollen by air, but rather presented this in terms of the volume changes for compression and decompression in relation to a balloon containing a urethane sponge.

2.4 Presence with Tele-Existence

In the field of Tele-Existence, there are studies in regard to using robots to communicate the sense of presence of humans remotely. Sakamoto et al. [19] defined the sense of presence as a strong feeling of "clearly, I am here", and is developing a re-motely operated android robot system to communicate this human "sense of presence". Modeled on actually present people, results obtained from an experiment using the robot "Geminoid HI-1", which closely resembles humans, and a remotely operated system, showed that it created a stronger sense of presence compared to existing media such as telephones or videoconferencing.

Sumioka et al. [20], as part of an approach to using a human-like robot as communication media, researched the impact of differences in human-like design in external form. The external form of communication media became closer in stages to a human, transitioning from only voice via speaker, to the trunk, the trunk and head, the trunk, head and two arms, to the trunk, head, two arms and one leg and finally to the trunk, head, two arms and two legs. The differences in how easy it was for the user to project a conversation partner on the robot were researched. As a result, it was reported that when the external form was of a trunk only, there was no significant difference to when the voice was only from a speaker.

The sense of presence is largely dependent on the user's perception and it is difficult to discuss simply from the physical perspective of external form and behavior. For example, when people communicate via a remotely operated robot, doubt arises as to whether it is the robot itself or the operator operating the robot from a remote location that recognizes the interaction between behavior. In response to this issue, Yamaoka et al. [21] use an autonomously operated robot, and survey differences in the impression evaluation in cases where the test subject is taught that the robot is being operated by a program and in cases where they are told that it is being operated by an operator. The result of this was that, regardless of these conditions, 2/3 of the test subjects reported that they felt like they were interacting with the robot itself, whereas the remaining 1/3 reported that they felt like they were interacting with the operator operating the robot remotely, and that this interaction was influenced by prior knowledge.

From this, in regard to the system that we are proposing for artificially presenting chest movements in human breathing, it is considered necessary to design and evaluate the considered system from both a physical perspective and the perspective of human recognition. First, in relation to external form, in an experiment by Sumioka et al. [20], it was found that where the external form was only the trunk, no significant difference was seen in terms of the user recognition to when it was just a voice from a speaker. From this, we can consider that the external form with just a trunk has very little effect on user recognition, compared to an external form containing arms/legs and a head, and we can exclude, as much as possible, the effect of external form, and present simulated movements of the chest, surveying its effect. Based, on this we decided to create the chest section only.

Furthermore, giving the robot an external form that resembles people who are actually there, as a human-like interface, promises to enable the user to experience the robot as if a person is actually present. On the other hand, however, this raises the issue that it does not suit situations wherein the robot is used as a substitute for an unspecified large number of people. In this paper, our objective is to examine the effects of the developed system on fear and anxiety by giving simulated physical contact to an unspecified "someone"; we have avoided "external forms" that resemble a specified "someone".

We decided to control the presented chest movements based on the breathing speed of actual adults; however, in this case, it is not possible to distinguish whether the effect of the movements presented by the proposed system are being recognized as chest movements when humans are breathing, or simply the effect of recognizing it as physical movement. For this reason, based on an experiment by Yamaoka et al. [21], when presenting the simulated movements of the chest, the test subject was told that the breathing of a different test subject in a different room was being sensed and presented via the developed system. We also decided to conduct an oral survey after the experiment, and confirm user recognition in relation to the presented chest movements.

3 Breath Chair: A Breathing Movement Simulation System that Uses Vacuum Pressure

The Breath Chair is a system designed to reduce fear and anxiety by giving users the feeling of physical contact through simulating the movement of a human chest during breathing. A study by Bauman et al. [22] of sitting time during weekdays in adults from 20 countries around the world revealed that Japanese adults spend a median length of approximately 420 min in total sitting each weekday. This study also found that this median sitting time was the longest in Japan compared to all countries examined. As the current lifestyle of Japanese people involves spending one-third of the day seated, we decided to have the chair-based device in our system simulate the movement of a human chest during breathing against the backs of users. This system uses the change in volume arising from repeated compression and decompression of a built-in polyurethane sponge in a vacuum to simulate the movement of a human chest during breathing.

3.1 System Configuration

This system has a built-in polyurethane sponge sealed in a compression bag to mimic the movement of a human chest during breathing (Fig. 2). Air is discharged from the compression bag-sealed polyurethane sponge by a vacuum pump to perform compression. To decompress the polyurethane sponge, the discharge of air by the vacuum pump is stopped and outside air is naturally insufflated. The Arduino Uno is used to control the electromagnetic valve via which air is repeatedly discharged and insufflated to compress and decompress the polyurethane sponge (Fig. 3).

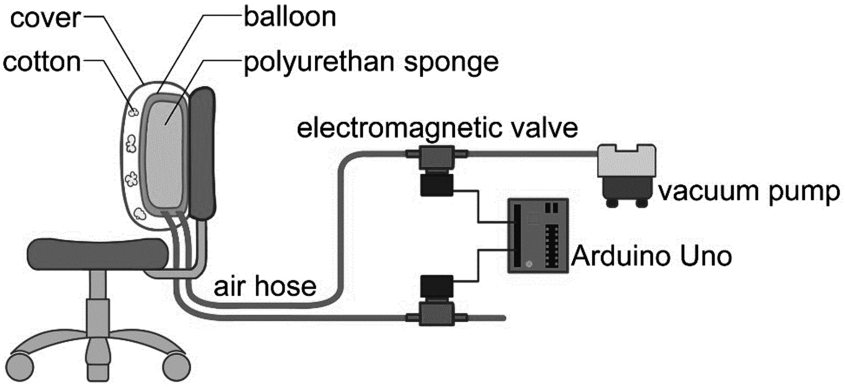

Fig. 2. System configuration

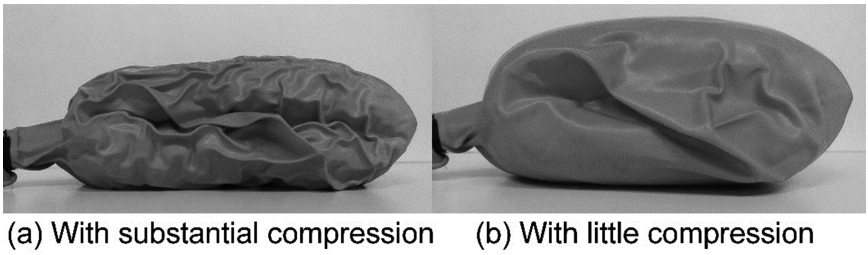

Fig. 3. Comparing the amount of volume in the polyurethane sponge

The amount of change in the circumferential length of the polyurethane sponge during compression and decompression is based on differences in chest expansion by adults Shôbo et al. [23] examined the difference in chest expansion during inhalation and exhalation when breathing deeply in an upright sitting position and reported a difference of 3.2 ± 1.2 cm at the third rib, 3.3 ± 0.8 cm at the xiphoid process of the sternum, and 3.0 ± 0.8 cm at the tenth rib. In our system, we set the amount of change in the circumferential length of the polyurethane sponge during compression and decompression at approximately 3.3 cm based on the intermediate point of the three aforementioned measurement points, or the results for the xiphoid process of the sternum—where the amount of change is said to be largest.

The breathing speed and the rate of the inhalation-exhalation rhythm of this system were based on average adult breathing speeds and rates [24]. At rest, the average adult breathes at a rate of 12 to 18 breaths per minute. The difference in chest expansion in this system was set so that the polyurethane sponge expansion was controlled at a rate of 12 times per minute, considering this was based on the results of measurements taken during deep breathing. Moreover, as the ratio of the rhythm of inhalation and exhalation in adults is almost 1:3, we also set the rhythm of inhalation and exhalation of air in this system to a ratio of 1:3.

4 Experiment: Effect on User Fear and Anxiety

We conducted an experiment in relation to this system, with the objective of alleviating fear and anxiety, with the aim of surveying the effects on user fear and anxiety. As a psychological indicator, we used the State-Trait Anxiety Inventory (hereafter, referred to as STAI) state anxiety scale, and as a physiological indicator, we used fingertip surface skin temperature. We provided visual stimulation to the test subjects to evoke the emotional behavior of fear or anxiety, and evaluated changes in each of the indicators, depending on whether this system was used or not.

The experiment used a room in an air conditioning facility in which people did not enter or leave. The lighting within the room, based on the experiment of Honda et al. [25], was set to approximately 30 lx. To eliminate factors affecting the sympathetic nervous system as much as possible, the test subjects were instructed to refrain from alcohol the day before and exercise on the day in question, and were not given any-thing other than water to drink 2 h before the start of the experiment. The visual stimulation was presented by placing a 23-inch display approximately 1 m in front of the test subject. During the experiment, the examiner was constantly absent from the test room, and the test subject was left alone in the test room.

Adults were chosen as the test subjects because they were able to adapt more easily to the test environment. Furthermore, as the Spielberger et al. [26] experiment, in which STAI was created, was an experiment aimed at university students, adult university students were also used in this experiment. This experiment was conducted on 12 men and women (age 21.5 $\pm$ 0.8 years old, mean $\pm$ S.D.) who consented to cooper-ate in the experiment. The consent of the test subjects was obtained after explaining, in both verbal and written form, the purpose of this study, the experiment method, the fact that they would not be disadvantaged for refusing to participate in the experiment, that they could freely choose to withdraw cooperation even after the experiment had started, that the acquired data would be used for statistical processing, that no investigation would take place to identify individuals, and that privacy would be protected.

4.1 Evaluation Indicators

In this experiment, we used psychological indicators and physiological indicators. The psychological indicator STAI state anxiety scale was used as an anxiety indicator.

Measurements of oxytocin, which are said to work to control fear and anxiety, mainly use the method of measuring levels of concentration within the blood. How-ever, due to the fact that it requires the invasive action of drawing blood and that there is no simple method for handling or processing the sampled blood, we did not use oxytocin as an evaluation indicator in this experiment.

STAI includes scales for both state anxiety and trait anxiety. The higher the value, the more anxiety this expresses, and distribution occurs for each respectively within a range of 20 points and 80 points. State anxiety is a transient state reaction to the phenomenon invoking the anxiety and measures “what I am actually feeling now”. The scale for trait anxiety is “normally, generally how do I feel”, and these are used as long-term indicators. The STAI used in this experiment, based on the STAI created by

Spielberger et al., newly creates items to express the state anxiety and trait anxiety in Japanese culture according to Hidano et al. [27], and these are scales to investigate reliability and appropriateness.

As a physiological indicator, fingertip surface skin temperature is used to indicate fear and anxiety. Fingertip surface skin temperature was calculated as the average value for every 30 s, using a thermistor thermometer (NXFT15XH103FA2B) attached to the fingertip ventral section of the index finger of the left hand. When the sympathetic nervous system is excited, there is constriction of the peripheral blood vessels, causing a reduction in the blood flow, and the skin surface temperature in the peripheral area decreases. Even in the experiment by Kumamoto et al. [28], where the perception level for pain, etc., and psychological anxiety increased, a drop in the skin surface temperature was reported.

4.2 Stimuli Invoking Emotional Behavior, Such as Anxiety or Fear

We used load stimuli for invoking emotional behavior such as fear or anxiety to invoke emotional behavior such as anxiety or fear in the test subject(s) and measure significant changes in its alleviation. As a means of invoking emotional behavior in the test room environment, visual stimuli invoke comparatively strong emotional behavior, and have the advantage of being non-invasive. Research into invoking specific emotional behavior through visual stimuli has been actively conducted [29, 30]. Furthermore, Honda et al. [25], in an experiment using visual stimuli, reported that significant changes occurred in fingertip skin surface temperature. Based on this, we used visual stimuli to invoke and stimulate anxiety and fear in this experiment.

For the visual stimuli in this experiment, we used images reported to invoke the emotional behavior of fear in the experiment by Alexandre et al. [31]. Alexandre et al. performed an experiment using an image showing one scene from a movie. Alexandre et al., for the image reported to invoke the emotional behavior of fear, used movies of virtually the same length of 210 s, that none of the test subjects in the experiment had seen up to that point. The two movies used were “Misery” (copyright; Castle Rock Entertainment, 1990), and “Scream 2” (copyright; Miramax Film Corp, 1997). The images used in this experiment were exactly the same as those used by Alexandre et al. with the same start and stop position, and the versions of the movies with Japanese language dubbing were used.

4.3 Giving False Information

The question of whether the physical movement caused by the compression and decompression of the polyurethane sponge is taken as the movement of the human chest when breathing is largely dependent on the user perception. For this reason, it was necessary to survey the impact of presenting simulated breathing before having the user recognize the movement of this system as movement of the chest when breathing. Therefore, with the aim of making the test subject recognize the movement presented by this system as chest movements when breathing in this experiment, we gave the test subject the false information in advance that “in the room next to the test room, there is one more test

subject. That other test subject is currently resting and his/her breathing is being sensed in real time and presented as the movement of the chest via this device". Furthermore, with the aim of surveying the effect of human contact with an unspecific "someone" rather than a specific "some-one" with which they had a relationship, they were only told that it was "one other person". In the oral survey after the experiment, the test subjects were informed that it was false information. Moreover, with the aim of confirming whether they perceived that the movement presented by the system was not just physical movement, but chest movement when breathing, they confirmed with the test subject in the oral survey whether they actually believed that there was another test subject in the next room.

4.4 Experimental Protocol

The procedure for the experiment is shown in Fig. 4. In this experiment, they were first sat in a chair in the test environment and kept in a restful condition for 3 min, closing their eyes and relaxing. Following this, measurement was performed via a questionnaire method using the STAI state anxiety scale and STAI trait anxiety scale. Next, in intervention 1, a visual stimulus was provided with the aim of applying mental stress. Following this, a measurement was performed with the STAI state anxiety scale and then they rested for a total of 6 min. Furthermore, in intervention 2, the same operation as for intervention 1 was repeated. Finally, an oral survey was conducted in regard to impressions and opinions about the experiment.

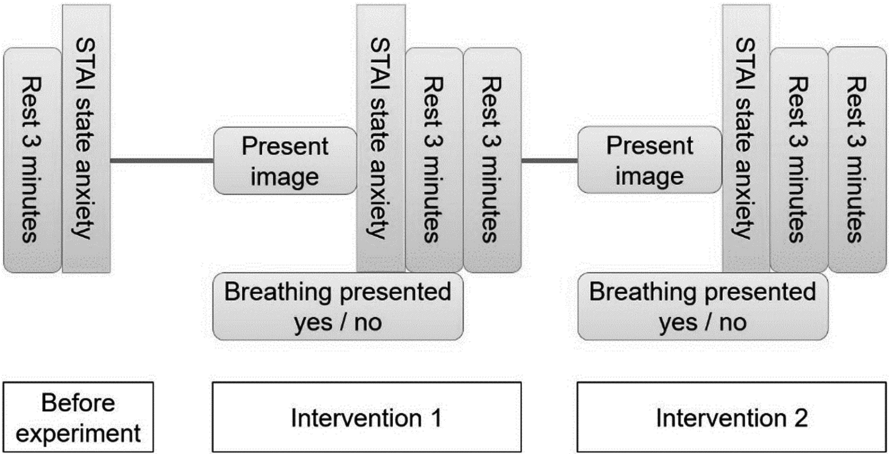

Fig. 4. Experimental protocol

For both intervention 1 and intervention 2, for one of the image presentations and 3-min rest periods directly after, with the condition of "with breathing presented", the system was operated and human chest movements when breathing were presented artificially. For the other time, under the condition of "without breathing presented", the system was not operated. This was conducted for the two image stimuli and under

conditions of both breathing presented and not presented, for a total of four times. Through random allocation to all 12 of the test subjects with 3 people per pat-tern, this provided a counter balance for order effect and interaction.

We conducted a one-factor analysis of variance on the STAI state anxiety scale. We also conducted a two-factor variance analysis in relation to the fingertip surface temperature. The Tukey method was used for the variance analysis multiple comparison. This was significant in case of a significance level of $p < 0.05$.

For the fingertip surface skin temperature, based on the experiment by Honda et al. [25], the average value was calculated every 30 s. Furthermore, in regard to the various images presented in intervention 1 and intervention 2, the average value during the rest period immediately before was used as the baseline, and the change quantity was calculated by deducting the baseline from the value when presenting the image.

In terms of the STAI state anxiety scale, those test subjects for whom this was lower when presenting image stimulus without breathing before the test, and those who subjectively were not seen to have had emotional behavior of fear invoked, were considered unsuitable for the purposes of this test, and five such test subjects were excluded from the analysis.

Based on our hypothesis that fear and anxiety would be alleviated, even in the case of simulated bodily contact, we presented simulated chest movements during breathing as one element felt due to bodily contact, and predicted that this would reduce fear and anxiety. We predicted that the presentation of breathing would cause the STAI state anxiety scale score to decrease and the fingertip surface skin temperature to increase. We conducted the experiment with the aim of verifying this prediction.

4.5 Result

The results of the STAI state anxiety scale are shown in Fig. 5. The results of the STAI state anxiety scale were 41.3 ± 8.5 points before the experiment, 52.3 ± 11.7 points without breathing presented, and 44.4 ± 6.6 points with breathing presented. The score without breathing presented was significantly higher ($F(2, 12) = 6.23$, $p < 0.05$) than the score before the test. Furthermore, although no significant difference was seen, compared to the conditions of without breathing presented, the score showed a decreasing trend under conditions where breathing was presented.

The results in terms of fingertip surface skin temperature are shown in Fig. 6. In terms of fingertip surface skin temperature, in the two-factor variance analysis, the main effect of conditions for with and without breathing were recognized ($F(1, 7)$ 7.63, $p < 0.05$). The main effect of time due to image presentation was recognized ($F(7, 7) = 11.02$, $p < 0.01$). When performing multiple comparisons in relation to time, a significant difference was seen between 0 s and 30 s before presenting the image. A significant difference was also seen between 0 s, 90 s, 120 s, 180 s, and 210 s ($p < 0.01$).

The result of the oral survey after the experiment was that 4 out of the 7 test subjects analyzed perceived the presented breathing to be that of an actual human. The remaining 3 people were dubious, considering that it may have been human breathing or alternatively created by a program. None of the test subjects failed to perceive it as human breathing.

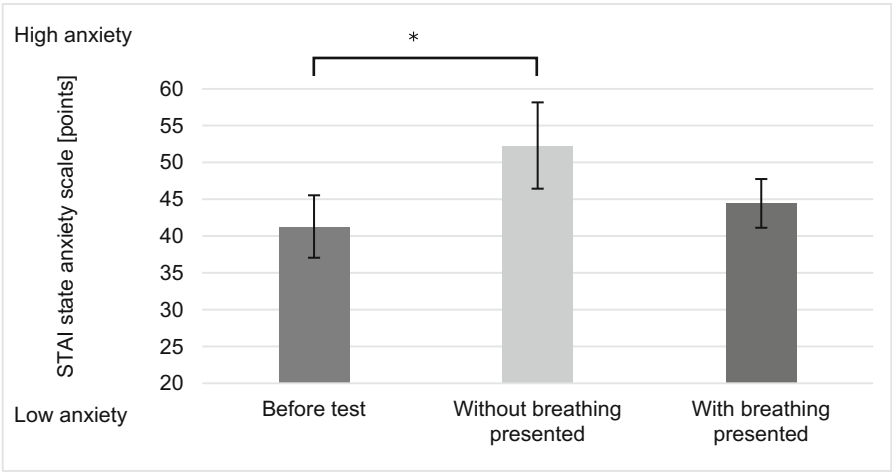

Fig. 5. Results of measuring the STAI state analysis scale (n = 7, *: $p < 0.05$)

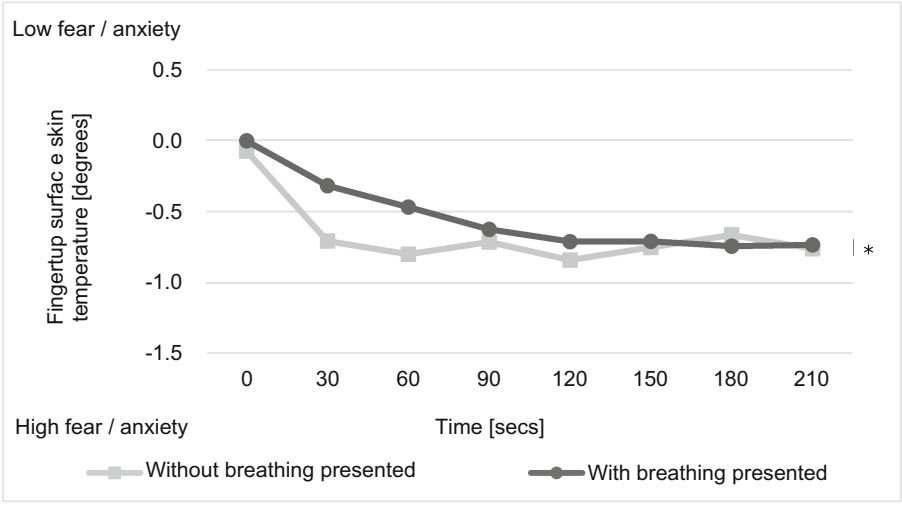

Fig. 6. Fingertip surface skin temperature measurement results (n = 7, *: $p < 0.05$)

4.6 Discussion

In the STAI state anxiety scale, there was a significant increase in the points for without breathing presented, compared to the points before the examination, so it is considered that for the test subjects being analyzed, this subjectively invoked the emotional behavior of anxiety. Furthermore, whereas no significant difference was seen, a decreasing trend was seen for with breathing presented compared to without breathing presented, so it is though that presenting breathing may have some effect in reducing anxiety.

In terms of fingertip surface skin temperature, it is thought that the decrease in temperature seen was due to the stimulus invoking emotional behavior of anxiety or fear causing the peripheral blood vessels to constrict as a result of the workings of the autonomic nervous system, which controls blood flow [32, 33]. Furthermore, Kistler et al. [34], from the results of an experiment using image stimulus, reported constriction of blood vessels and a decrease in the fingertip surface skin temperature. Based on this, the significant decline over time in the fingertip surface skin temperature seen in the experiment described in this paper can be considered to be a result of the emotional behavior of fear and anxiety. Furthermore, from the significant difference in whether breathing is presented, it is suggested that the operation presented in this system is effective in alleviating fear and anxiety.

From the oral survey, the false information of "one more test subject" was either completely or half-believed. From this, it is considered that the operation of this system was perceived as being the movement of the chest due to breathing. Further-more, as a significant difference was seen in the fingertip surface skin temperature, even in the case of a simulated bodily contact with an unspecified "someone", it is considered possible to alleviate fear and anxiety.

However, from among the 12 test subjects in this experiment, 5 test subjects for whom subjectively the emotional behavior of anxiety was not invoked were excluded and the analysis was conducted on 7 subjects. In consideration of the small sample size of the analyzed subjects, the test subject results of both those who completely believed or half-believed were analyzed together. From the results of this paper, it is difficult to determine whether this was the result of perceiving the operation presented by this system as the simulated physical contact of an unidentified "someone" or simply perceiving a simple physical operation. In relation to this issue, we are looking into continuing the experiment after dividing the test subjects into those who completely believe the information and other test subjects.

5 Conclusion

In this paper, we described the development of the "Breath Chair" system that pro-vides a simulated feeling of physical contact to reduce fear and anxiety. The Breath Chair simulates the movement of a human chest during breathing, thereby eliciting a feeling of physical contact. This system achieves this simulated movement of a human chest during breathing by repeatedly compressing and decompressing an in-built polyurethane sponge in a vacuum to change its volume. This gives users a feeling of physical contact that is intended to reduce their fear and anxiety.

We surveyed the effect of the developed system on fear and anxiety from the simulated physical contact envisaged as being from an unidentified "someone". Using the STAI state anxiety scale, we analyzed test subjects in whom fear and anxiety were subjectively invoked. For those test subjects who completely believed or half-believed the false information that there was "another test subject", a decreasing trend in the number of points on the STAI state anxiety scale, and a significant difference was seen in the fingertip surface skin temperature was seen depending on whether or not breathing

was presented. Based on this, the possibility that fear and anxiety could be alleviated, even when the bodily contact is simulated with an unidentified "someone", was suggested.

Moving forward, we are looking into continuing the experiment after dividing the test subjects into those who completely believed the false information and those test subjects who only half-believed the information. By investigating the presentation of simulated physiological information and the effect on emotional behavior, we plan to further study the positive benefit produced by people being together, without being limited to only a specific "someone" with whom one has an intimate relationship, such as friends, lovers, or family.

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