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History and Recent Advances of the Japanese Society of Biofeedback Research

Leo O. Oikawa[1] · Akihisa Hirota[2] · Hiroki Uratani[3] · Masahito Sakakibara[4]

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Abstract
This article provides an overview of the history of the Japanese Society of Biofeedback Research (JSBR) and presents some of its recent advances. Most of the research papers published in the JSBR journal (*Biofeedback Kenkyu*) have been written in Japanese, and therefore have had very few opportunities to reach global readers. We would like to present some of important findings previously published there. First, we present the history of the JSBR. Secondly, we will focus on paced breathing, which is instrumental in achieving relaxation in heart rate variability biofeedback (HRV-BF). We will look back on the origin of slow-paced breathing in Japan, that could be attributed to the concept of *Tanden* breathing (abdominal paced breathing) practiced in Zen meditation. Thirdly, we will introduce some of the current research progresses of JSBR, especially focusing on the development of a non-contact sensing technology and relaxation device. Finally, we will explain about a very recent trial, the "*Suu-Haa*" Relaxation Technique, which we hope may be useful for helping people cope with the SARS-CoV-2 (COVID-19) crisis.

Keywords The Japanese Society of Biofeedback Research · Paced breathing · Zen meditation · Non-contact sensing · SARS-CoV-2 (COVID-19)

Introduction

The year 2020 was a painful one for all of us around the globe. With the outbreak of the SARS-CoV-2 (COVID-19) pandemic, sometimes even the healthiest and strongest individuals were infected and hospitalized, many precious lives were lost, and we were instructed by our governments to "stay home". Life as we knew it; travelling, dining out and socializing, all came to a sudden standstill. The Summer Olympic/Paralympic Games of Tokyo 2020, which is supposed to be a worldwide gathering of super-athletes in the prime peak performance of their lives were postponed for the first time in history, but Japan nevertheless gathered much international coverage via the media, due to its struggle with the SARS-CoV-2 (COVID-19) starting from the cruise ship "Diamond Princess" pandemic.

On the other hand, the "stay home" campaign installed by the Japanese government, gave us an opportunity to stay indoors more. With less strenuous hours of travelling to and indulging in repeated meetings and conferences away from home, we were given the much needed time. With time, came energy to sit, focus and reflect on achievements of the past, and to summarize knowledge accumulated through the years, stacked on shelves and filed in cabinets, otherwise forgotten in daily routine of hard work.

Using this ideal timing, Oikawa and Sakakibara communicated with each other, remembering being asked by Paul Lehrer (editor in chief, Applied Psychophysiology and Biofeedback) many years ago, to summarize and introduce the history and some of the recent advances of JSBR for readers in the international biofeedback community. Although many well-researched topics have been presented at meetings and also published in the JSBR journal and other psychophysiology journals in Japan for many decades, most have been

✉ Masahito Sakakibara
msakaki@md.ccnw.ne.jp

1 Department of Rehabilitation Medicine, Asahikawa Medical University Hospital, Asahikawa, Japan

2 Department of Child Psychology, Kamakura Women's University, Kamakura, Japan

3 EQWEL Co.,Ltd, Osaka, Japan

4 Department of Psychology, Aichi Gakuin University, 12 Araike Iwasaki-cho, Nisshin-shi, Aichi 470-0195, Japan

presented and/or written in Japanese, and therefore have had very few opportunities to reach global readers.

We present here, several topics that recently received attention from JSBR and were published in its journal. We will focus on the development of the non-contact sensing technology and relaxation device, and mention a very recent "*Suu-Haa*" Relaxation technique that was aired on national television in Japan, which may help people cope with the SARS-CoV-2 (COVID-19) crisis.

History of the Japanese Society of Biofeedback Research

Inception of the Japanese Society of Biofeedback Research

Research on biofeedback began in Japan at a time closely paralleling the early days of research elsewhere in this field. Following the establishment of the Association for Applied Psychophysiology and Biofeedback (AAPB) in 1969, we formed the Biofeedback Research Conference in 1973 in Japan, and the first meeting on biofeedback research was held in October of this year. David Shapiro (Mental Health Center, Harvard University) attended the meeting and delivered a lecture titled "Role of feedback and instructions in the voluntary control of human blood pressure." This meeting was endorsed by Hitoshi Ishikawa (Tokyo University), Tadanobu Mizuguchi (National Cancer Center Hospital), Yoshinori Matsuyama (Doshisha University), Yo Miyata (Kwansei Gakuin University), and Hisashi Hirai (Sophia University). In 1977, a total of two hundred Japanese and US researchers attended a Symposium titled "Biofeedback and Self-Control" conducted at Kyoto International Conference Center.

Following the activity of the Biofeedback Research Conference, the Japanese Society of Biofeedback Research (JSBR) was established in 1983. Members from three major research fields; medicine, engineering, and psychology, came together to form this society. This interdisciplinary academic collaboration is a unique characteristic of JSBR, probably the first of its kind implemented in Japan. Hitoshi Ishikawa was voted the first president of JSBR. He was the founder of the Department of Psychosomatic Medicine in Tokyo University Branch Hospital. He and his colleagues applied blood pressure, respiration, and electromyogram biofeedback in a clinical situation, and they conducted massive biofeedback research, and dispersed the information through an abundance of lectures/seminars. Hisashi Hirai (Sophia University) of the Psychology field, as the second president of JSBR, conducted animal and human experiments in biofeedback with his colleagues, and translated several English textbooks on biofeedback into Japanese, to disseminate the latest work on biofeedback at that time. Sueharu Tsutsui (Toho University School of Medicine), the third president of JSBR, conducted the third International Conference of Biobehavioral Self-Regulation and Health, entitled "Biobehavioral self-regulation in the East and the West," in Tokyo in 1993. Several prominent foreign researchers such as Neal E. Miller, Joe Kamiya, Joel F. Lubar, and Andrew Steptoe attended the conference.

Katsuyuki Shirakura (Tokai University) served as the fourth president of JSBR from 1999, followed by Chiaki Nishimura (Toho University) from the Engineering field, the fifth president from 2002 to 2009. JSBR established a certification system for biofeedback technicians in 1988, and Nishimura adopted a continuing education component to this system (i.e., adoption of a point-based system). Table 1 shows the names of the successive presidents to date; sixth Shinobu Nomura (Waseda University), seventh Kouji Tsuboi (Toho University) and eighth Masahiro Hashizume (Toho University), are consecutively from the Medicine Field.

Numbers of Presentations at the JSBR Conferences

"*Biofeedback Kenkyu*" (Japanese Journal of Biofeedback Research; JJBR), the academic journal of the JSBR, has been published biannually, with papers mostly written in the Japanese language, with/without English abstracts, focusing on original biofeedback research conducted in Japan

Table 1 Successive presidents of the Japanese society of biofeedback research

Chairperson	Period	Name	Affiliation	Field
1st	1983–1985	Hitoshi Ishikawa	Tokyo University Branch Hospital	Medicine
2nd	1986–1992	Hisashi Hirai	Sophia University	Psychology
3rd	1993–1998	Sueharu Tsutsui	Toho University	Medicine
4th	1999–2001	Katsuyuki Shirakura	Tokai University	Medicine
5th	2002–2009	Chiaki Nishimura	Toho University	Engineering
6th	2010–2012	Shinobu Nomura	Waseda University	Medicine
7th	2013–2015	Kouji Tsuboi	Toho University	Medicine
8th	2016–	Masahiro Hashizume	Toho University	Medicine

and on the activities of the society. Researchers belonging to three academic research fields (medicine, engineering, and psychology) have each been taking turns to host annual meetings. The number of presentations from the three fields at each annual meeting is presented in Fig. 1. Because the 1993 JSBR annual meeting was jointly conducted with the third International Conference on Biobehavioral Self-Regulation and Health, the number of presentations could not be counted (note blank year; 1993).

Figure 2 shows the proportion of presentations from the three fields in each decade since the first meeting. Although the percentage values for the last decade represent only six years, the percentage of presentations from the three fields has gradually converged to similar values in the last two decades. One of the reasons for the reduction in presentations from the Medicine field at the JSBR annual meetings, may be that the concept of psychosomatic medicine and the use of biofeedback equipment has become a daily routine of medical practice in Japan; e.g., in the areas of rehabilitation and nursing, that more and more presentations are being made within their separate fields.

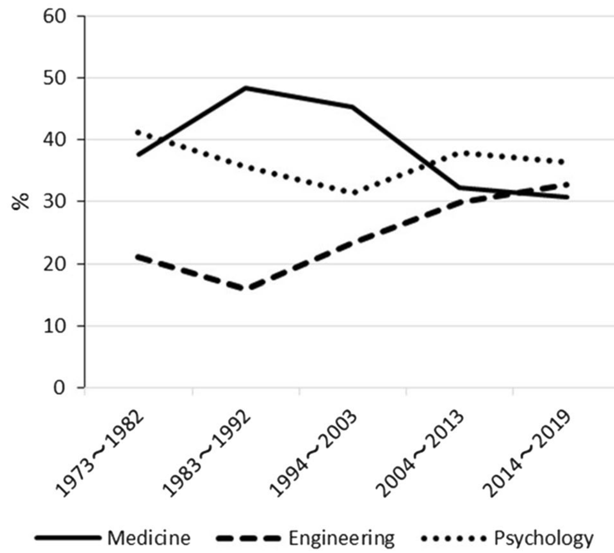

Fig. 2 Percentage of the total number of presentations per field during each decade

Research on Slow-Paced Breathing in Japan

Paced breathing is thought to play an important role in relaxation in biofeedback. In particular, slow-paced breathing at a rate of 0.1 Hz contributes to heart rate variability (HRV) biofeedback, where paced breathing elicits resonance in the cardiovascular system (Lehrer, 2007). In Japan, while the role of paced breathing at resonance frequency in HRV biofeedback has been discussed by Umezawa (2000), Lehrer and Vaschillo (2002), and Oikawa and Lehrer (2008), its origins could be attributed to the concept of *Tanden* breathing (abdominal paced breathing) practiced in Zen meditation, more so than to HRV biofeedback.

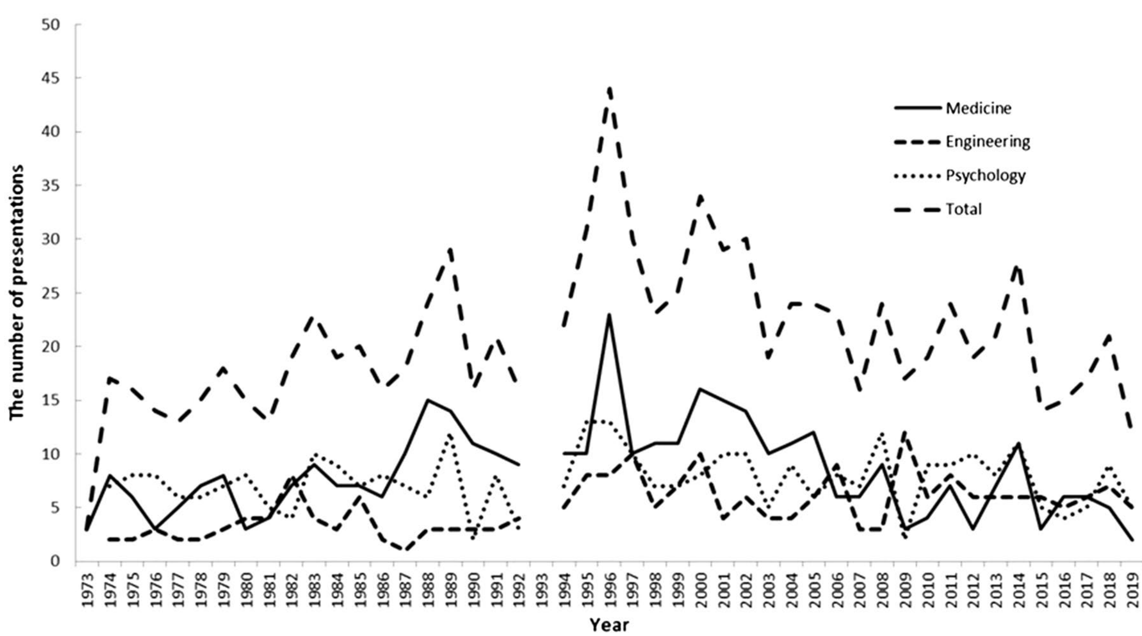

Fig. 1 Number of presentations per research field at each annual meeting

Tanden Breathing (Abdominal Slow-paced Breathing)

Tanden or *Kikai Tanden* (the ocean of *Ki*-energy) is considered to be located below the navel (Katafuchi, 2014). Although the *Tanden* is located in three places in the body, the one we refer to is called the lower *Tanden*. The term *Ki* (Chinese, *chi*), a key concept in traditional Chinese thought and medical theory, refers to vital energy that circulates through the human body. It is considered vital to the preservation of health and sustenance of life (Waddell, 2011). It should be noted that *Tanden* differs from breathing.

The integration of *Tanden* and breathing has been described in "*Yasen Kanna*" written by Zen Master Hakuin Ekaku (1685–1768) in 1757. Although "*Yasen Kanna*" literally refers to idle talk on a night boat, it describes Hakuin's Zen meditation sickness and how he dealt with these experiences (Hakuin, 1757/1934). Hakuin was a Buddhist priest of the Rinzai sect, a school of Zen Buddhism. He practiced at temples in various parts of Japan to gain enlightenment. Between ages of 26 and 31, he developed a disorder that he called "*Zen byo* (Zen sickness)" (Yoshizawa, 2016), because of his vigorous engagement in Zen practice (Izuyama, 1985). Although the exact nature of the disorder is unknown, from his description of its symptoms, modern writers (e.g., physicians) have diagnosed it as tuberculosis, pleurisy, nervous breakdown, or some combination of the three (Takayama, 1975; Waddell, 2011). Hakuin tried acupuncture, moxacautery, and medicines to improve his illness, but none of them worked and his condition continued to worsen.

Hakuin heard about a hermit Hakuyū, and he visited his place in Kyoto (a cave in the Shirakawa district of Kyoto). There, he learned the "*Naikan*" (a technique of introspective meditation), a regimen that pays attention to *Tanden.* Master Hakuyū said to Hakuin, "*If you decide to practice this secret technique, you should, for the time being, cease your practice of Zazen (seated practice of Zen). Set aside your Zen study. First of all, it is important that you get a sound night's sleep. Before you close your eyes, lie on your back, put your legs together, and stretch them out straight, pushing downward as hard as you can with the soles of your feet. Next, draw all your primal energy down into the elixir field* (i.e., *Kikai Tanden*)*, so that it fills the lower body, the space below the navel* (*lower Tanden*)*, down through the lower back and legs, to the soles of the feet*" (Waddell, 2011). Hakuin, who learned this method, gradually recovered his health and was able to regain his energy in Zazen practice. Subsequently, Hakuin integrated therapeutic "*Naikan*" techniques with Zen meditation and saved several monks who also contracted Zen sickness during their Zen training. In addition, Hakuin emphasized the importance of breathing by respectively quoting an old Korean physician and a Chinese philosopher as follows, "the true person breathes from his heels while the ordinary person breathes from his throat" and "when the vital energy is in the lower heater (lower *Tanden*), the breaths are long; when the vital energy is in the upper heater, the breaths are short" (Hakuin, 1757/1934).

In the Samurai era (Edo period) in Japan, because spiritual theory was emphasized in sword technique and traditional arts, ideas such as training the *Tanden* improves the state of mind and body, and enhances spirituality (Zen mind) had a great influence on the traditional culture (Katafuchi, 2014). Therefore, *Tanden* breathing (abdominal breathing) has been considered as one of the methods to realize spirituality (Durckheim, 2003; Hirata, 1811/1977).

Tanden breathing at a slower rate seems to have important beneficial effects on autonomic health among Zen practitioners. Lehrer et al. (1999) examined the effects of *Tanden* breathing on HRV in eleven Zen practitioners (six Rinzai and five Soto monks). Findings revealed that *Tanden* breathing increased HRV within the range of low- and very low-frequency spectral bands. Since these data are consistent with the hypothesis that slow-paced breathing at a particular frequency can produce resonance of the cardiovascular system (Vaschillo et al., 2002, 2006), Lehrer et al. (1999) suggested that further direct assessment of baroreflex gain in this population could determine whether Zazen enhances the gain in homeostatic reflexes.

On the other hand, studies on *Tanden* breathing in Japan have been conducted intensively by Hideho Arita and his colleagues. They have discussed that *Tanden* breathing causes an increase in serotonin levels in the brain. Fumoto et al. (2004) examined the effects of *Tanden* breathing at 3–4 cycles/min (cpm) (inhalation for 6–8 s and exhalation for 9–12 s) on electroencephalogram (EEG) parameters and serotonin levels in twenty-two healthy participants (aged 21–54 years). In the experiment, EMG was recorded to monitor abdominal muscle contraction (near the right anterior superior iliac spine), through which participants were able to observe and confirm the contraction of the abdominal muscles by viewing the EMG signal on an oscilloscope. It should be noted that the abdominal muscle contraction occurs during exhalation phase. After participants had mastered the breathing maneuver, they were examined in an eyes-closed condition (without the visual feedback of EMG signal). Findings revealed that, when abdominal breathing (20 min) was performed with eyes closed, low-frequency EEG alpha waves were replaced with high-frequency alpha waves, and subjective vitality increased. No such changes were observed at rest alone. Because urinary serotonin levels increased significantly after abdominal breathing, Fumoto et al. (2004) concluded that the activity of serotonin neurons in the brain elicited such EEG changes.

In addition, *Tanden* breathing induces activation of the anterior prefrontal cortex (PFC) in accordance with increase in whole blood serotonin levels. Yu et al. (2011) examined the effects of *Tanden* breathing at roughly the same 3–4 breaths/min rate previously set by Fumoto et al. (2004) on hemodynamic changes in the PFC using near-infrared spectroscopy, EEG, and whole blood serotonin (5-HT) levels. Fifteen healthy volunteers (mean age = 38 years) were examined during a 20-min session of *Tanden* breathing. The most important findings are summarized as follows: (1) the level of oxygenated hemoglobin in the anterior PFC (BA10 and 9) was significantly increased during *Tanden* breathing; (2) EEG revealed increased alpha band activity and decreased theta band activity during and after *Tanden* breathing; (3) a significant increase was seen in whole blood 5-HT levels correlating with augmented EEG alpha band activity ($r = 0.60$, $p = 0.019$); (4) there was a reduction in negative emotion compared to before *Tanden* breathing. Yu et al. (2011) suggest that activation of the anterior PFC and the 5-HT system may be responsible for the EEG signal changes and the improvement of negative emotion observed during *Tanden* breathing.

Effects of Paced Breathing on Psychophysiological Aspects

In Japanese biofeedback research, Akio Umezawa and his colleagues have conducted several experiments on the relationship between relaxation and respiration, where they found that a prolonged post exhalation pause occurs during relaxation (Umezawa, 1993). Based on the previous examinations, they have intensively conducted several systematic studies on the effect of slow-paced breathing, and they have identified its characteristics.

To examine the relationship between the pressure of end-tidal CO_2 (PetCO_2) level and relaxation, Terai and Umezawa (2003) used a biofeedback method for PetCO_2 in twelve participants (aged 18–52 years). In the biofeedback task, the range for decline in PetCO_2 was set as − 0.5–2.0 mmHg from baseline (DEC task), and that for increase in PetCO_2 was set at plus + 0.5–2.0 mmHg from baseline (INC task); the respiratory rate was set at 6–12 cpm. As a result of analysis of each 30-min trial, it was found that while PetCO_2 decreased significantly, it did not increase significantly. Seven out of the 12 participants reported that they were more relaxed during the DEC task. Since the decline trial was easier to achieve than the increase trial, Terai and Umezawa (2003) suggested that PetCO_2 biofeedback-assisted relaxation tends to induce hyperventilation in beginners.

Terai and Umezawa (2015) examined the effect of progressive slow breathing on gas exchange in ten healthy participants (aged 23–29 years), in which participants were engaged progressively in a series of paced breathing at 12/10/8/6/4/2 cpm (5 min each). Findings revealed that the PetCO_2 level remained unchanged throughout all breathing conditions. Although the tidal volume (TV) gradually increased under paced breathing below 6 cpm, minute ventilation (VE), CO_2 output (VCO_2), and CO_2 equivalence (VE/VCO_2) decreased gradually. In addition, the total power of HRV and baroreflex sensitivity increased significantly in the 4–6 cpm conditions. These results suggest that the slow-paced breathing conditions improved the efficiency of gas exchange and enhanced cardiac vagal activity. Therefore, Terai and Umezawa (2015) concluded that slow-paced breathing may have a clinical effect through the resting function.

In addition, Terai and Umezawa (2016) examined the role of respiratory sensations during paced breathing. In a field experiment, 137 male and 63 female college students (mean age = 21.8 years) were told to progressively slow their breathing from 20 to 2 cpm in steps of 2 cpm. In addition, they were instructed to evaluate subjective comfort and sensation of dyspnea in each breathing condition. The following results were obtained. 1) Scores on subjective comfort decreased in the conditions involving paced breathing at 20–16 cpm and 4–2 cpm, while the sensation of dyspnea increased in the conditions involving paced breathing at 20–18 cpm and 8–2 cpm. 2) Each participant had a comfortable pace (CP), which is defined as a combination of the greatest comfort and the least dyspnea. The paces at which more than 20 participants felt comfortable were 6, 8, 10, 12, and 14 cpm. Paced breathing at plus or minus 2 cpm from the CP significantly reduced subjective comfort and significantly increased the feeling of dyspnea. Thus, Terai and Umezawa (2016) suggested that the relaxation caused by paced breathing is determined mainly by the respiratory sensation (Fig. 3).

Recent Advances in the Japanese Society of Biofeedback Research

One of the unique characteristics of biofeedback research in Japan is the development of sensing technology and equipment for enhancing relaxation.

Recent Studies on Sensing Technology in Japan

Generally, a biofeedback system is constructed based on physiological information obtained by a sensor attached directly to the body. However, patients with psychiatric disorders, such as depression, may experience anxiety to being restrained by the use of sensors. Unno et al. (2014) developed a novel biofeedback system using a microwave radar that measures non-contact heart rate by detecting minute body movements caused by the heartbeat. They examined the effectiveness of the biofeedback system by examining if it measured an increase in the high-frequency (HF) component of HRV in eight healthy male students (mean

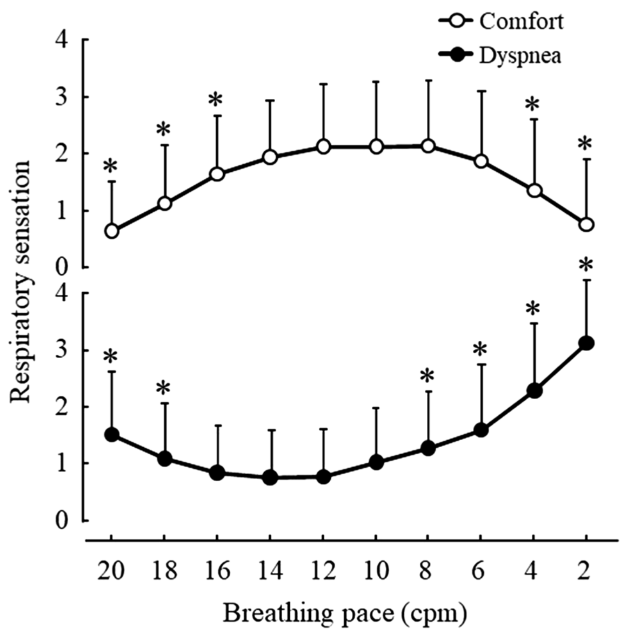

Fig. 3 Mean scores and standard deviations for subjective comfort (open circles) and sensation of dyspnea (black circles) under paced breathing conditions. Reproduced from Terai and Umezawa (2016)

age = 22 years). The HF component increased significantly under the biofeedback condition for 10 min as compared to the control condition (a 10-min rest), suggesting that the non-contact biofeedback system may be effective for use with the clinical population.

A non-contact sensing technology has also been developed using camera photography. This technology detects heart beats by capturing the slight successive changes that occur in human face color accompanying blood flow. Tezuka and Nakamura (2018) developed a system to calculate the heart rate by extracting the pulse wave obtained from the change in face color. Although body movements and room lighting fluctuations interfere with an accurate estimation of the pulse wave, they improved the performance of the system, and demonstrated a good correlation coefficient of RR interval between the pulse detection using camera photography and standard ECG measurements ($r = 0.978$). They used this system to test HRV biofeedback (paced respiration) in four participants and confirmed that the HRV changed along with the respiration pattern.

Development of Technology for Enhancing Relaxation

In general, it is known that respiration becomes naturally deep and slow in a relaxed state, while it could be caused as a result of voluntary slow-paced breathing. In Japanese biofeedback research, devices have been developed for using respiratory activity to induce relaxation. Aoyama et al. (2005) developed a virtual reality system that uses human respiratory activity as an input signal for inducing relaxation. The device provides participants with the sensation of riding ocean waves using virtual images, sounds, wind, and chair movements. Because these virtual factors work in conjunction with participants' respiratory activity, they were able to perceive their respiratory activity through sight, hearing, and touch. Assuming that the system would slow participants' breathing and lead them to relaxation, Aoyama et al. (2005) examined the effect of this system on heart rate, HRV, EEG, and subjective rating of relaxation. Results showed a decrease in heart rate, an increase in HRV (CV-RR), and an increase in EEG alpha waves, and most participants experienced psychological relaxation by using this system.

Development of a Stuffed Animal Toy to Induce Relaxation in Children

Recently, devices and software that promote relaxation using personal computers have been developed, but it seems difficult for younger children who are not accustomed to using such devices or software. Uratani (2016) developed a stuffed animal toy (i.e., a stuffed bear) so that children can intuitively learn relaxation by adjusting their breathing according to the movement of the stuffed animal's abdomen. Uratani and his colleagues have intensively conducted several systematic studies on the effect of the stuffed bear.

In a study on 48 healthy children aged 4–12 years, Uratani and Ohsuga (2014) first investigated whether the children could adjust their breathing to the device. The children were instructed to adjust their breathing according to the movement of the stuffed bear's abdomen. Uratani and Ohsuga (2014) examined the degree of agreement between the stuffed bear's abdominal movement cycle and the children's breathing cycle to determine whether the children were able to breathe properly (if they matched exactly, the synchronization rate would be 100%). Findings revealed that while the synchronization rate was low for those under 6 years of age (mean = 18.9%), it was relatively high for those aged over 6 years (mean = 38.9%). This result suggested that the stuffed bear, the paced breathing device, may be useful for older children.

In the second examination, Uratani et al. (2014) used this device to examine the respiratory interval with the greatest HRV in 10 healthy children, where they hypothesized that the respiratory interval would cause a relaxation effect. Although a 10-s respiratory interval was expected to be useful for relaxation because of the resonance effect on the cardiovascular system, such a slower respiratory interval often seems to be difficult to achieve even in adults (Terai & Umezawa, 2016). They investigated the degree of psychological relaxation occurring during paced breathing trials.

Findings revealed that the respiratory interval with the maximized HRV was in the range of 10 to 12 s. However, subjective ratings of relaxation and ease of breathing showed no difference between the respiratory interval with the maximized HRV and other respiratory intervals (i.e., relatively short intervals).

Based on the previous examinations, Uratani and Ohsuga (2018) improved the paced breathing device (the stuffed bear) for mobile use. It was equipped with a built-in sensor that enables breathing measurement, breathing guidance, and pulse measurement so that children can easily learn slow-paced breathing. Figure 4 shows the specifications of this device. Two airbags (Size: 115 × 85 × 10–50 mm), two air pressure sensors (CQ30A-G102, MKT Taisei), two solenoid valves, a pneumatic motor (AJK-B2701, Xiamen AJK Technology), and a micro controller (Arduino Uno, Smart Projects) were placed inside the stuffed bear (Rilakkuma Kuttari® stuffed animal toy, size: 560 × 360 × 140 mm, San-X) (Fig. 5). One airbag was set in the upper abdomen as a respiration-leading airbag (moving device), while the other was placed in the lower abdomen as a respiration sensor (sensing device). In a study on 58 healthy children aged 4–12 years, Uratani and Ohsuga (2018) used the device to test whether the children could regulate their breathing properly. Findings revealed that more than 70% of the children were able to adjust their breathing to the device's movement without substantial practice.

Subsequently, using this mobile device (Fig. 5), they conducted a study to assess the relaxation effect in nine healthy children aged 8 to 10 years. The device measures the resting respiratory rate and moves the stuffed bear's abdomen at child's respiratory rate (average during rest). During this, if the synchronization rate between the abdominal movement of the stuffed bear and the children's breathing meets a criterion (± 20%) three times across five breaths, the interval of

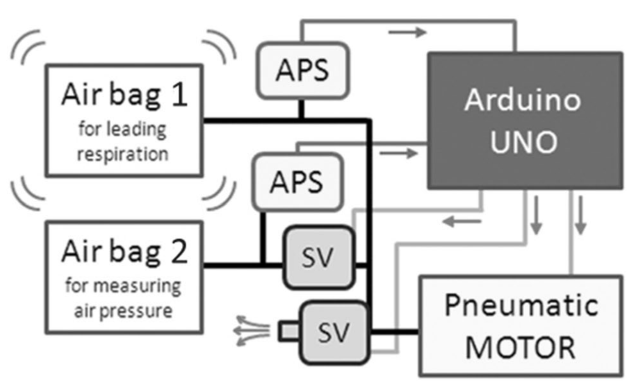

Fig. 4 Device constitution placed inside a stuffed bear. *APS* air pressure sensor, *SV* solenoid valve

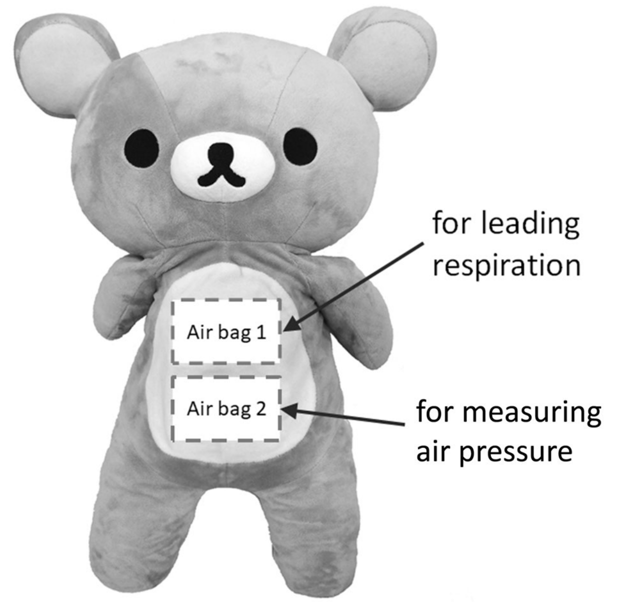

Fig. 5 Stuffed bear (Rilakkuma Kuttari®, San-X) as a paced breathing device

abdominal movement of the stuffed bear is programmed to increase by 0.5 s. The respiratory interval ranged from 2.7 to 5.3 s during the resting period, whereas the interval increased from 5 to 7.9 s at the end of the trial. The participants could not adjust to further slow intervals induced by the stuffed bear because of the time period (3 min). In this assessment, participants were also required to hold the stuffed bear that did not move for the same period (control condition). On comparing pulse rates before and after the assessment, it was found that the pulse rate decreased significantly under the condition of paced breathing using the stuffed bear compared with the control condition.

In the future, this device will also be able to provide feedback on whether the child has achieved relaxation based on the physiological information obtained from the pulse wave during breathing induction. By using such a device to support relaxation, children will be able to learn breathing methods autonomously. In addition, it is expected that the relaxation support device would be used in educational and medical settings in Japan. Further, if children become accustomed to breathing at home from their early age, it is expected that they will acquire stress tolerance and will be able to exert their abilities naturally even in stressful situations.

Introducing the "*Suu-Haa*" Relaxation Technique

Through the SARS-CoV-2 (COVID-19) crisis, and reduced opportunities for individual one-on-one contact, we found a need to change our attitude and approach of how to utilize biofeedback for our patients/clients. One recent attempt by Oikawa was to utilize two methods of ICT (information and communication technology) which is being constantly used in Japan since the SARS-CoV-2 (COVID-19) crisis began; 1) the internet and video conferencing application for the actual one-on-one treatment, and 2) the mass media for dissemination of the results to the general population, hoping that the televised technique may promote national curiosity about the methodology on the subliminal level. At the same time, Oikawa thought it necessary to use layman's language, not using such scientific/medical terminology as "psychosomatic medicine" and "biofeedback."

"*Asa-ichi*" (Translated as "First thing in the morning") is a popular national broadcast morning program (8:15–9:54AM) run by NHK (*Nippon Hoso Kyokai*; Japan Broadcasting Corporation), the only public media organization in Japan. They were going to do a feature on "*Hiye-syo*" (hypersensitivity to cold), and Oikawa was approached by NHK with an opportunity to treat several participants with "*Hiye-syo*" via the internet. Oikawa utilized the Zoom video conferencing software application (Zoom), often being used these days throughout Japan for "remote" internet conferences. The program was then edited and aired nationally from 8:15 to 9:00AM (The program was shortened this day for the National Diet live broadcast) on 17 February, 2021. This was a very unique opportunity to treat "remotely," which may be appropriate during the SARS-CoV-2 (COVID-19) pandemic.

We recruited four healthy adults (all were female) who reported some sort of hypersentivity to cold surroundings (e.g., cold hands/feet, lower back pain/edema of extremities/frequent urination induced by cold weather). Participants were excluded if they had any current acute or chronic illness undergoing medical treatment. The participants were asked to abstain from alcohol, caffeine, and strenuous exercise on the day of training. Written informed consent was given prior to the procedure.

The session consisted of the following; 1) interview before procedure by NHK staff on the type and severity of the sensitivity to cold, and 2) a ten-minute regimen of "*Suu-Haa*" training via Zoom, lead by Oikawa, with continuous thermographic readings monitored by NHK staff.

After the preliminary interview by NHK staff, participants were asked to take off their stocking or socks, and to sit comfortably in a chair with their legs parallel with knees together.

The "*Suu-Haa*" Relaxation Technique consists of a combination of slow breathing and rhythmical skeletal muscle tension (RSMT), adopted and revised from the original manuscript by Lehrer et al. (2009). With slow paced inhalation, the participants were asked to claw their fingers and toes simultaneously, just enough to feel how muscles get tense. With slow paced exhalation, they were asked to slowly relax their fingers and toes, and to feel the warmth of their thighs through their palms. The commercial naming of "*Suu-Haa*" Relaxation Technique was coined by communication between NHK and Oikawa, for the "*Asa-Ichi*" viewers, although the actual technique has been used and revised/refined by Oikawa through over a decade, under no specific naming. "*Suu*" and "*Haa*" are onomatopoeias expressing inhalation (through lightly-closed teeth and lips) and exhalation (through open mouth), focusing on *Tanden* breathing mentioned above.

There was a gradual rise in temperature of the palms of all four participants during the ten minutes of "*Suu-Haa*" training. Although the rise in temperature did not necessarily correspond with age or subjective symptoms, the "*Hiye-syo*" had diminished immediately after the first implementation of the "*Suu-Haa*" training.

At the end of session, each participant was asked to practice the ten-minute training twice daily, and told that NHK would make a follow-up telephone call after a week to ask about any changes they experienced.

The "*Hiye-syo*" remained diminished for the whole week, in all four participants. These are the testimonials from the four participants after one week of home practice; Participant 1: in her 40 s "*I used to wear two to three layers of socks, but quit soon after the session. I also began to perspire in my forehead and back when I implement the practice*," Participant 2: in her 40 s "*My palms feel warm now*," Participant 3: in her 50 s "*I feel an improvement in bloodflow, and my shoulders don't feel tense like they used to*," Participant 4: in her 60 s "*My hands have begun to perspire, and my fingers are pink, not white like they used to be.*"

Oikawa has been using this combination technique in clinical practice for two decades; slowly developing the technique starting out with the combination of Autogenic Training and electromyogram (EMG) biofeedback (Oikawa et al., 1999), skin temperature/skin conductance/diaphoremeter/plethysmogram (bio)feedback, Autogenic Biofeedback (Norris et al., 2007), and HRV-BF (Heart Rate Variability Biofeedback) using slow paced breathing at 0.1 Hz (Oikawa & Lehrer, 2008). A former method used by Oikawa during his wintering in Syowa Station of Antarctica (2014–2016); a combination of Autogenic Training and skin temperature (bio)feedback, was introduced in the past on another popular NHK program "*Tameshite-Gatten*" (Translated as "Try it and…Ah-ha! (It all makes sense!)") aired on 23 Dec 2015.

That technique was also used for the treatment of participants with "*Hiye-syo*."

As far as the authors know, this is the first attempt to implement the combination of both breathing and RSMT at a "slow" rate, not necessarily at a certain frequency of 0.1 Hz mentioned in other literature (Lehrer et al., 2009). Although a 0.1 Hz breathing or RSMT technique is possibly ideal to produce large oscillations in all cardiovascular measures, most adults breathe at a rate of twelve to eighteen breaths per minute, and we see many experience discomfort and bouts of dyspnea trying to pace their breathing at six breaths per minute, in clinical practice (Terai & Umezawa, 2016).

This is also the first attempt of using a video conferencing system such as Zoom (not yet available during Oikawa's wintering during 2014–2016) for the actual training, without any direct contact with or time to build a personal/professional relationship and structured treatment regimen with the participant(s). Oikawa emphasizes the importance of IT integration to the method, for the "remote" and "safe" use of non-contact biofeedback and other psychophysiological methods for patients/clients during the SARS-CoV-2 (COVID-19) pandemic.

We saw no problems with the internet connection or the Zoom application, or any major difference, compared to one-on-one treatment using physical contact in the clinical setting of a clinic, concerning the immediate effect and result of the training, as well as the follow-up of the participants.

Since the Japanese government declared a state of emergency and has repeatedly been preaching the "stay home" campaign, many workers are now working "remotely (not in an office, but in their own rooms at home)," and infection-prone elderlies are now staying indoors, having more time to watch television. Since the daily "*Asa-ichi*" ratings are close to 10% on average, we believe that the "*Suu-Haa*" Relaxation Technique has reached over 10 million viewers throughout Japan. With "*Hiye-syo*" being a major ailment among the Japanese, many may already be practicing the "*Suu-Haa*" Relaxation Technique, in days following the televised program. This was, in a way, a large-scale social experiment, which we hope will eventually build up into a newer method, worth revising/refining in later days; a simple combination of breathing and muscle tension/relaxation is one way of implementing biofeedback and psychophysiology into the daily lives of the average Japanese household.

Conclusion

Our attempt through this article was to introduce just some of the current topics at JSBR, especially of the collaborative work among the three separate fields of medicine, psychology and engineering. Biofeedback has come a long way from the earlier work done by our predecessors, some of whom we have had many great opportunities to communicate with and sometimes discuss with at a heated level, and our presentation here through the article is only a glimpse of the forty years of history here at JSBR in Japan.

The SARS-CoV-2 (COVID-19) pandemic has brought on a huge burden on not only the international scene but also on the "simple daily life" that we always took for granted. Uncertainty of what will become of life past SARS-CoV-2 (COVID-19), a pandemic which has had a huge toll on economy, is a huge issue, but research has always been an area of low funding, to begin with. The best way is to collaborate, and to try to understand what others in other fields and from around the world are doing, because that may bring about new ideas, and hopefully give birth to newer concepts and futuristic equipments.

We would like to emphasize the use of ICT; a much needed tactic during the SARS-CoV-2 (COVID-19) pandemic, since most if not all schools and corporates in Japan are now using online technology to communicate with and to relay messages to one another. Using the internet for online communication, is one way of treating individual clients/patients "real-time" with our methodology. Using mass media to relay messages not only to fellow researchers but also to laymen who in turn may utilize that "never-seen-before" technique they saw on television for their clients in whatever areas/fields they work in; be it academic, athletic or commercial, we can only imagine. Using a stuffed animal toy to achieve relaxation, using non-contact sensing technology, using the "*Suu-Haa*" relaxation technique, these are but some of the very new approaches based on basic science and clinical practice, which has slowly evolved through the unique medical/engineering/psychological collaborative works of JSBR.

Reach in; that is what we must do with our history, and inner self. What for? To reach out; that is what we must do with the knowledge we have accumulated through the years, and more often into the English speaking community. This inward and outward oscillation, we hope, should produce enough energy to reach beyond the forced boundaries of SARS-CoV-2 (COVID-19), or any new crises that wait ahead trying to block our paths. Biofeedback is not a remnant of the past; It is within us, among us, just waiting for the right timing, and a new method to reach out. We, at JSBR, believe that to the very end.

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