Ethereal Phenomena - Interactive Art, Meditation, and Breathing Biofeedback: From Mind and Body Wellness Towards Self-Transcendence

Silvana Malaver Turbay
Keio University Graduate School of Media Design
Tokyo, Japan
s.malaver@keio.jp

Igor Igorevich Segrovets
Tokyo Institute of Technology
Department of Mechanical Engineering
Tokyo, Japan
segrovets.i.aa@m.titech.ac.jp

George Chernyshov
Keio University Graduate School of Media Design
Tokyo, Japan
chernyshov@kmd.keio.ac.jp

Jiawen Han
Keio University Graduate School of Media Design
Tokyo, Japan
hanjiawen@kmd.keio.ac.jp

Christopher Changmok Kim
Keio University Graduate School of Media Design
Tokyo, Japan
chris.kim@kmd.keio.ac.jp

Kai Kunze
Keio University Graduate School of Media Design
Tokyo, Japan
kai@kmd.keio.ac.jp

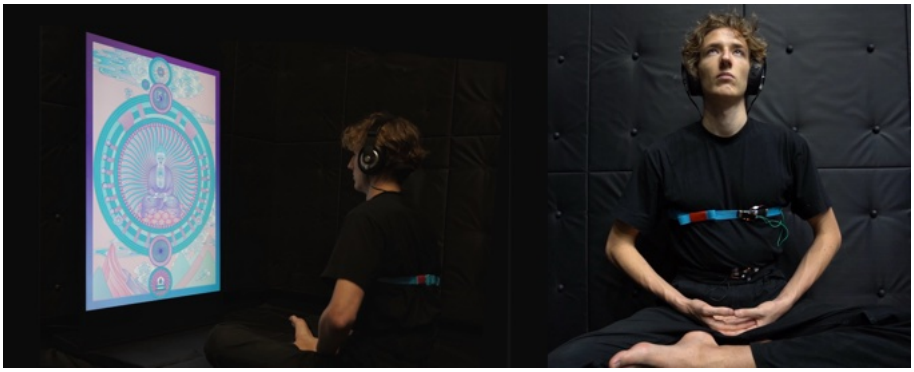

Figure 1: Ethereal Phenomena (left) | User study participant (right)

ABSTRACT

Ethereal Phenomena is an interactive installation in which a user meditates in front of a digital illustration based on Tibetan thangka art that reacts to the way they breathe. The biofeedback of the breath makes the artwork an extension of the user's body and a reflection of their mind. By combining art, sound, and biofeedback, Ethereal Phenomena becomes a unique meditative experience that aims at producing physical and mental wellness and that has the potential to induce a state of self-transcendence or pure consciousness.

CCS CONCEPTS

• **Human-centered computing → Interaction design process and methods**; **User studies**;

KEYWORDS

Art installation, Embodied interaction, Breathing biofeedback, Meditation, Consciousness

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1 INTRODUCTION

Ethereal Phenomena integrates traditional Tibetan knowledge and symbolism on meditation with contemporary scientific findings on biofeedback and breathing techniques into an interactive artwork. It looks to produce overall physical and mental wellness, which occurs mainly through exercising the breath. Yet, like in Tibetan meditation, the ultimate purpose is to access a state of pure consciousness that can be defined as "a state of being rather than thinking or doing" [19]. As an artwork, Ethereal Phenomena invites to a contemplative disposition. Through symbolic, visual, and audio

stimuli, it engages the user conceptually and perceptually. Ethereal Phenomena works both as a meditation tool and as an art piece, addressing multiple levels of experience, all connected through the breath.

Breathing influences us physiologically and psychologically. It is a visceral function of the body, but we can also control it deliberately [16]. From both the perspectives of Western medical research and of Tibetan tradition, it is possible to consider two main types of voluntary breath: thoracic and abdominal. Slower and deeper abdominal breathing is more calming, efficient, and possesses cumulative health effects. Accelerated, shallow thoracic breathing, on the contrary, produces and indicates unease and anxiety [16]. In Ethereal Phenomena, the user wears two breath sensor straps (fig.3), one around the chest and another around the abdomen, so that both types of breathing can be identified.

We curate the interaction so that each layer of the illustration reacts differently, mainly depending on the type and pace of breath. Broadly described, abdominal breathing generates more movement and a slower pace makes the motion smoother. This is meant to incite the user to breathe abdominally and with longer periods of inhalation-exhalation. The different parts of the thangka and audio indicate how the breath is fluctuating. The whole work progressively transforms and reveals new movements and sounds throughout the meditation, helping the user to remain focused and engaged.

A user study comparing two meditation sessions, one assisted by the interactive work and another non-guided, suggested that the meditation with Ethereal Phenomena made participants feel more relaxed, focused, and aware of their breath and mental state. Furthermore, several participants expressed having had a sensation of timelessness and absence of thoughts during the interactive meditation which coincide with several aspects of Transcendental Meditation, implying that the meditation experience of Ethereal Phenomena can potentially give the user a sense of self-transcendence or pure consciousness.

The research and development of the work takes an experimental and speculative approach necessary to deal with consciousness, an ambiguous and controversial topic at the intersection of several fields of study [2].

The main contributions we provide in this paper are as follows: (1) We present an initial prototype of Ethereal Phenomena, tracking and visualizing both thoracic and abdominal breathing in an installation. (2) We describe the design process inspired by Tibetan tradition and wearable technology, the rational behind auditory and visual feedback, and the overall user experience (biofeedback guidance using Tibetan meditation aesthetics). (3) We present the results of an initial user study (n = 20), comparing Ethereal Phenomena with standard breath meditation. We show indications that Ethereal Phenomena can encourage especially novice users to meditate more and that users seem to have higher perceived relaxation and focus after the experience.

2 RELATED WORK

Meditation, breathing, and biofeedback have in common that they all entail a connection between body and mind [5, 8, 10, 20]. For thousands of years, Tibetan tradition—as well as many other traditions from Hinduism and Buddhism—has developed meditative and breathing techniques that bring extraordinary benefits for the mind and body [16]. Contemporary Western science has acquired crucial knowledge from traditional meditation. There is a lot of research showing through scientific methods and instruments the implications and advantages of meditation practices [18].

Though, most studies have dissected the techniques and isolated them from their context, setting apart from meditation, among others, the role of art, music, and symbols. In the process of secularization, mainly the easier-to-measure and definite characteristics have been considered, and meditation as a practice aspiring to pure consciousness has been overshadowed by more evident practical wellbeing benefits [19].

One of the few studies that considers changes on cognition and performance and also evaluates the state of self-transcendence or pure consciousness is focused on Transcendental Meditation [19]. According to Frederick Travis, Transcendental Meditation consists, basically, of sitting down and mentally repeating a mantra. Self-transcendence or pure consciousness is a state in which the mind is free from content, provoking a realization of non-duality, of dissolution of the boundaries of self and, therefore, of unity with everything [19]. Practitioners of Transcendental Meditation characterized pure consciousness by the absence of time, space, and body [19]. A deep and slow pace of breath is also one of the physiological characteristics of Transcendental Meditation.

Another relevant form of meditation for this research is Tibetan Yantra Yoga, which focuses in particular in the breath. As practitioners, Anyen Rinpoche and Allison Choying Zangmo explain that Yantra Yoga looks for mental and physical health together with the development of wisdom, compassion, altruism, and, at the core of all these, the non-dual state of pure consciousness, known also as Buddha Nature [16]. One of Yantra Yoga's primary techniques is training deep abdominal breathing.

The advantages of abdominal breathing are also supported by recent research focused on breathing retraining [7, 9]. Thoracic breathing tends to be more common in our stressful contemporary lifestyle. Shortness of breath—thoracic and shallow breath—occurs when we are unsettled, anxious, stressed, worried, or physically ill. Breathing with the chest is not harmful by itself but it indicates the absence of health and it can negatively condition our mental and physical states. In opposition, when breathing abdominally, lower lungs exchange oxygen for carbon dioxide seven times more efficiently and deep breaths contribute to slowing down the heart rate, stabilizing blood pressure and inducing muscle relaxation [16].

A breathing retraining technique consists of isolating the abdominal breath by trying to not move the chest, inhaling and directing all the air into the stomach, inflating it, and then exhaling slowly, letting down the abdomen [9]. This exercise is implemented on research developing a smartphone app for abdominal breathing retraining through biofeedback [7]. The study points out that, while so far breathing retraining has been done by health professionals, utilizing new technologies can make it more accessible.

Visualizing biofeedback has tremendous potential [8, 21]. It allows users to monitor the way they breathe, informing them of their physiological and psychological condition in real-time so they can deliberately modify their breath. It also contributes to managing diverse health issues like stress and anxiety. It must be highlighted that to make biofeedback training effective, just displaying the

biosignal is not sufficient as the practitioner must possess certain knowledge on how to correctly modify their activity.

A lot of interaction research into meditation and biofeedback focuses on bodily reflection, health encouragement and a heightened feeling of embodiment in general [4, 6, 10, 11, 17, 23]. Most of these type of studies have not addressed matters of consciousness.

Nevertheless, artistic practices integrating technology have been more open to this. Artist and academic Roy Ascott considers that there is not a consensus on the definition of consciousness but that art is enough open to navigate it and reframe it without needing to map it or explain it: "The mysterium of consciousness may be the final frontier for both art and science, and perhaps where they will converge." [2]. Some cases of artworks that follow this idea are Dream Temple [15] and Wave UFO [14] from the artist Mariko Mori. These architectural installations seek to influence the state of consciousness of the user, the former by adapting Buddhist imagery into visuals and the latter by processing the users' brainwaves. Like Dream Temple, Wish Happiness from Kristina Mah [13] is an art installation inspired in Buddhism. It adapts traditional Tibetan Buddhist rituals into a wheel that people can rotate together, producing a shared experience that is meant to motivate compassion. Another related artwork is AuxeticBreath [22], an installation composed of auxetic structures that displays rhythmic respiratory rate and tidal volume. AuxeticBreath shows the relevance of how artistic means mixed with technology can help to promote awareness of breathing properly to produce wellness.

3 DESIGN CONCEPT

Ethereal Phenomena emerges from the speculation that there is a key in the integration of artistic expressions and meditation to achieve health benefits but also self-transcendence. As a holistic tradition, in Tibetan culture, art and music are also part of meditation rites. Notably, Tibetan thangka, paintings that usually depict deities or mandalas [3]. Thangkas have not only a devotional purpose or an aesthetic appeal but their contemplation is a form of meditation. Besides having a rich symbolism that shows a complex metaphysical view of reality, these images are characterized by their layered composition and multidimensional spatialization that are meant to produce a state of self-transcendence through contemplation [1]. As for music, diverse instruments and chants are part of meditation rites. This is the case of mantras, repetitions of phrases, words, or syllables considered sacred and that come from ancient Sanskrit and Pali. Beyond their intellectual meaning, the sound is supposed to produce a physical affection, influencing the body directly.

The style of the illustration in Ethereal Phenomena follows the aspect ratio and rules of composition from thangka painting. The central figure is a buddha or enlightened being sitting on top of a lotus flower, a symbol of purity and enlightenment [3]. Behind it, a circular and translucent rainbow represents the fully enlightened body that becomes pure light, an ethereal phenomenon. The symbol of the rainbow signifies the body-mind-spirit connection and the transcendence of the self. The mountains and clouds evoke the primary element that wants to be expressed with the work: air, wind. Other traditional elements can also be found, like the stupa, a relic that represents the body of the historical Buddha (Siddharta), the sun and moon discs that mean enlightenment, and the sacred syllable 'om', recalling the idea of emptiness with compassion [12] and providing from the visual perception a link to the sound. All the components follow the standard measurements of traditional thangka painting, a sacred geometry in which every figure is interconnected by having harmonic proportions. The colours, however, do not follow the traditional symbolism. The blue, purple, green, and pink gradients align the style of the illustration to the digital format of the work. This palette also happens to induce relaxation and calmness, setting the atmosphere for meditation.

Each layer interacts in a particular way with the breathing of the user (fig.2). With every abdominal inhalation, the outer frame turns more purple and pink (A), the buddha comes closer to the user (B), and the rainbow rotates counter-clockwise (C). With every abdominal exhalation, the outer frame turns more blue and green (D), the buddha becomes smaller (E), and the rainbow rotates clockwise (F). If the user breathes only with the chest, these elements will barely move. Seeking to produce a harmonious motion, the user intuitively breathes deeply with the abdomen. A slower pace contributes to making the motion smoother and also activates different features. If the period of inhalation-exhalation is long and deep enough, the moon disc rotates around the rings (G) and the background landscape becomes alive, the clouds softly fly (H) and the mountains change colour (I). Thoracic breathing is synchronized with the upper wheels (J) while abdominal breathing is synchronized with the lower wheels (K), mirroring the body. To incite more abdominal breathing, if the thoracic amplitude is higher than the abdominal, the speed of the wheels is reduced and the buddhas chest emanates a pink glow. Altogether, the interaction of the elements is perceived more intuitively than rationally, so the appropriate breathing—deep, slow, and predominantly abdominal—occurs more or less automatically. To provide support to the biofeedback, seven pairs of lotus flowers surrounding the buddha were added. With each breathing period, a pair of flowers blooms (L). After seven periods, the sun disc rotates around the rings (M) and the cycle re-starts. Thus, the user is not focused on counting breaths—so the meditation does not become a sort of quantifiable contest—but still has a sense of progression that aids them to concentrate. Every cycle of seven periods progressively activates a new feature: the motion and glowing of the rings around the buddha, the transparency of certain circles so that the background landscape can be better appreciated (N), and the spatialization of sound. In this aspect, Ethereal Phenomena has a component of gamification, since it motivates the user to maintain their focus in order to gradually unveil the artwork. The user is guided through their aesthetic sense.

The audio of Ethereal Phenomena is a 'sound mandala'. There is a sound for each layer of the illustration and there are various kinds of sounds. The most evident is the constant repetition of the mantra-like chanting in Japanese that means: "reality is hidden, reality is an illusion, it is actually a dream". The interpretation resonates with Buddhist philosophy. But the fundamental of this singing is that, through the repetition the meaning starts to vanish and becomes sound, just like a mantra. The audio effects are composed of several types of Tibetan bells; some of them mark the period of inhalation-exhalation, working as an audio biofeedback mechanism together with the rotation of some objects in the image. Low frequencies subtly but powerfully induce the user's perception into a sort of trance. Certain organic sounds mixed with digital

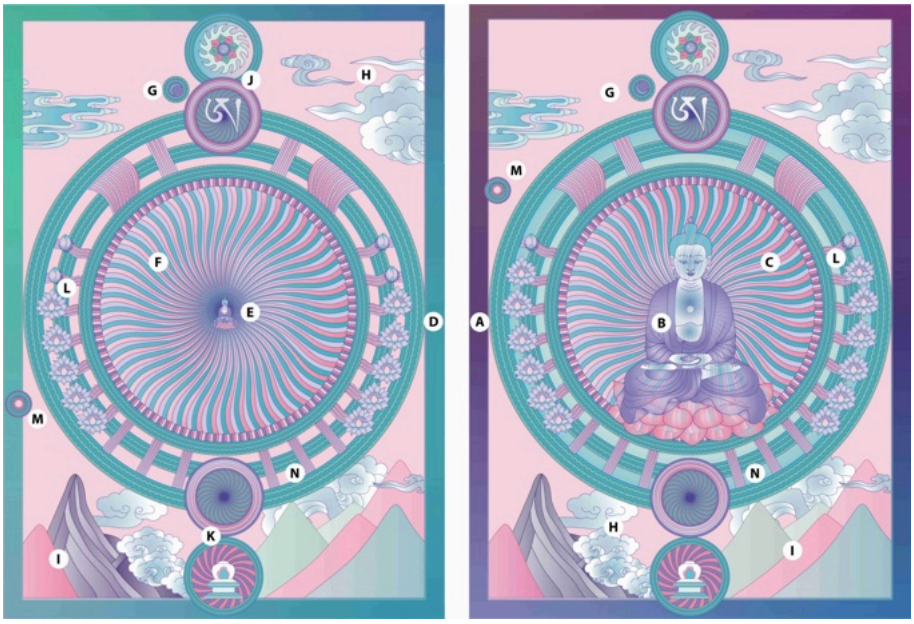

Figure 2: Visual interaction mechanism of Ethereal Phenomena. A period of exhalation (left) - inhalation (right)

keyboards represent a union between apparent opposites, mind and body, the traditional and the modern.

3.1 Implementation and Hardware

The installation of Ethereal Phenomena (fig.3) is composed of a screen monitor (A)—placed vertically so that it matches the illustration—, a pair of headphones (B), and two breath sensor straps (C). The above devices are connected to the interaction program. The breath sensor straps are self-made hardware to be worn around the thorax and around the abdomen. They are adjustable belts with an embedded microcomputer connected to an elastic conductive polymer that measures the expansion of the body when breathing. When the user has completely exhaled and the polymer is not stretched at all, the output data number is 0. When the user inhales, the polymer stretches and the corresponding data number is larger. The breathing data is streamed wirelessly to the program controlling the embodied visual and audio interactions.

4 USER STUDY

In order to evaluate the impact on the users of Ethereal Phenomena as a meditation tool, we carried out a test comparing it with a non-interactive/non-guided meditation. We recruited 20 participants (male= 10, female= 9, other= 1) in the range of 23 and 42 years old (mean=27.7). No participant meditated almost every day; six meditated once a week; two meditated once a month; two meditated a few times a year; four had meditated a few times in life; six had never meditated. For the test, every participant did a ten-minute session of each of the two types of meditation. Half of the participants did first the non-interactive and the other half did first the interactive meditation. They were asked to fill questionnaires before and after each session. The questionnaire taken before worked as the baseline to evaluate the effect of the sessions. On five-point Likert scales, from strongly disagree to strongly agree, participants selected if they felt (a) relaxation, (b) focus, (c) awareness of the breath, and (d) awareness of the mental state, (e) awareness of the present moment, (f) awareness of the body, (g) awareness of the environment, (h) awareness of sounds, (i) anxiety, and (j) distraction. These parameters were selected based on the potential positive or negative influence on wellbeing meditation can produce.

Additionally, we collected physiological data from the participants before, during, and after the meditations. The respiratory rate of the thoracic breathing and the abdominal breathing were registered through the two breath sensor straps used for the interaction with Ethereal Phenomena. Electrodermal activity and heart rate variability were registered through wrist-worn device (fig.3). We plan to analyze physiological data to reveal if prior discussed correlations exist in our future work. Such as if interactive meditation slows down the cardiac rhythm, indicating that the user is more relaxed, or if the users showing a higher heart and respiratory rate tend to breathe more with the chest than with the abdomen.

4.1 Initial Results from the Questionnaires

A repeated-measures ANOVA (fig.4) with a post hoc pairwise comparison using the Bonferroni correction showed that the level of (a) relaxation, (b) focus, and (c) awareness of breath was not significantly different between the baseline and the non-interactive meditation. On the contrary, when comparing the baseline with the interactive meditation there is a significant increase. In the case of the level of (d) awareness of mental state, there is not a significant difference between the baseline and the interactive meditation but there is a significant difference when comparing the non-interactive and the interactive meditation; in this case, there is a higher score for the interactive meditation.

Figure 3: Outline of Ethereal Phenomena (left) | Breath sensor straps (center) | Heart rate and electrodermal activity devices (right)

REPEATED-MEASURES ANOVA	Tests of Within-Subjects Effects	Pairwise Comparisons		
Significant difference p = **< .05**		Baseline vs. Non-interactive	Baseline vs. Interactive	Non-interactive vs. Interactive
(a) relaxation	F(2, 38) = 8.067, p = **.001**	.445	**.003**	**.043**
(b) focus	F(2, 38) = 11.012, p = **.000**	.446	**.004**	**005**
(c) awareness of the breath	F(2, 38) = 12.202, p = **.000**	.254	**.000**	**.013**
(d) awareness of mental state	F(2, 38) = 4.396, p = **.019**	1.000	.063	**.043**
(e) awareness of the present moment	F(2, 38) = 2.226, p = .122	1.000	.106	.311
(f) awareness of the body	F(2, 38) = 2.693, p = .081	1.000	.089	.331
(g) awareness of the environment	F(2, 38) = .805, p = .455	1.000	1.000	.926
(h) awareness of sounds	F(2, 38) = 1.714, p = .194	.405	.358	1.000
(i) anxiety	F(2, 38) = 2.637, p = .085	1.000	.057	.463
(j) distraction	F(2, 38) = 1.988, p = .151	1.000	1.000	.126

Figure 4: Results of the repeated-measures ANOVA test

However, the level of (e) awareness of the present moment, (f) awareness of the body, (g) awareness of the environment, (h) awareness of sounds, (i) anxiety, and (j) distraction was not statistically significant.

4.2 Initial Interview Feedback

Besides questions asked in Likert scales, we included open-ended questions about meditation experiences. We extracted key comments as the following: (1) Five participants stated wanting to repeat the interactive experience and even to use it in their daily life to meditate with more frequency. (2) Three participants with little or no experience at all in meditation considered that Ethereal Phenomena helped them to better access meditation practice and claimed to be encouraged to meditate more. (3) Four participants mentioned that their perception of time was altered and they felt that Ethereal Phenomena was considerably shorter than the non-guided meditation or that they did not perceive time at all. (4) Four participants said that they were so focused in the experience that thoughts would not appear at all, in contrast to the non-guided meditation. (5) Two commented that they were abstracted from their body sensations.

5 DISCUSSION

The overall significant difference on the level of (a) relaxation, (b) focus, (c) awareness of breath, and (d) awareness of mental state among the stages of the test suggests that the interactive meditation positively impacted the users considerably more than the non-interactive meditation. We infer that the main influential factor on it was the breathing biofeedback interaction. The biofeedback requires a continuous, maintained, and controlled way of breathing (slow abdominal breathing) in order to affect visuals and sound. Thus, it demands full attention from the user, impeding them from being distracted by the external environment. The focus on the experience and awareness of the breath are almost unavoidable. Due to these, the user is also unable to wander in thoughts, which brings mental clarity and, consequently, awareness of the mind. Altogether, these elements tend to generate a feeling of relaxation.

Nevertheless, the level of (e) awareness of the present moment, (f) awareness of the body, (g) awareness of the environment, (h) awareness of sounds, (i) anxiety, and (j) distraction the difference between the three stages was not statistically significant. We infer that the definition of these parameters might have been confusing or inappropriate due to the nature of Ethereal Phenomena. On the one hand, the parameters were chosen considering too general aspects of diverse kinds of meditation. They were focused on evaluating effects usually encountered in mindfulness type of meditation, which has a different approach and effects from Transcendental Meditation. On the other hand, probably it was not clear for the users how to determine if there is awareness of the present moment or distraction since it was not specified if it was distraction from the

breath, from the outer environment, from the interaction. Similarly, while Ethereal Phenomena produces an awareness of the breath, it generates as well a sensation of abstraction from the body and from the environment and sounds outside the work. Here, again, it was not clarified if the environment and sounds were the ones of the installation. Finally, the fact that the level of anxiety did not show a significant change raises several questions. First, it appears contradictory that the level of relaxation did have a significant variation. Second, the context of an experiment set up might make the participants slightly anxious. Third, biofeedback sometimes can be counterproductive and cause anxiety, as has been seen in other studies [7].

The qualitative feedback from the participants allowed us to better understand factors that were not evaluated in our questions. From the points (1) and (2) in the Initial Interview Feedback (sec.4.2), we suggest that, on the one hand, Ethereal Phenomena can make meditation more appealing to inexperienced practitioners and motivate people to practice it more frequently. On the other hand, it can make certain benefits of meditation more immediately attainable. Many types of meditation seek for the practitioner to quiet their mind and breathe properly. However, this is in fact extremely difficult. Ethereal Phenomena helps users to achieve some immediate meditation benefits with less effort. This is not implying that it is a better kind meditation, but simply it widens the range of the advantages of guided and assisted meditation. The points (3) to (5) showed several traits of Transcendental Meditation such as the absence of time, body, and mental content.

6 CONCLUSIONS

Ethereal Phenomena has a hybrid nature as an artwork and meditation tool. It combines multiple techniques that entail a correlation between body and mind—meditation, biofeedback, and breathing retraining. So far, with the collected data it is not possible to state that Ethereal Phenomena produces self-transcendence but the statements from the participants of the user study show similarities with Transcendental Meditation. The analysis of the collected biosignals together with a redesigned questionnaire focused on evaluating self-transcendence might provide better results on the effects of Ethereal Phenomena, opening as well the possibility of improving the design of the current prototype of the work.

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