Ming Shan Digital Experience: Immersive Technology for Traditional Taoist Meditation

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The *Ming Shan Digital Experience* is an immersive installation designed to support meditation in the context of a new Taoist center. Its creation confronted current academic literature on digital technology for meditation with the practical and cultural requirements of Taoist practice. Quantitative and qualitative learnings show the effectiveness of multimodal biofeedback on individual and collective meditative experience. Now instated in the Taoist center, the installation opens new perspectives for combining digital technology with ancient practice.

CCS Concepts: • **Human-centered computing** → Interaction design; Interaction design process and methods; Scenario-based design; Interaction design; Empirical studies in interaction design; Interaction design; Interaction design process and methods; User interface design.

Additional Key Words and Phrases: user experience, meditation, cultural heritage, biofeedback

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1 CONTEXT

Ming Shan is a new Taoist center in Switzerland housing meditation rooms, residencies, a temple, and a restaurant. Supported by public funding, the center established a partnership with EPFL+ECAL Lab, a design research center in Switzerland, to explore how digital technologies could support meditation practices.

Taoism is one of the three main systems of Chinese philosophy alongside Confucianism and Buddhism. Reference to Taoist meditation appeared around 500 BC with Lao Tzu and now comprises a range of practices. Taoist meditation is considered to be an internal process that induces the flow

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of energy along paths of the body through two phases: concentration and relaxation, followed by internal observation. Though it employs various body positions and techniques, meditation is guided by the mind until it becomes natural for experienced practitioners [Gouédard, 2014].

2 CURRENT STATE OF RESEARCH

Breath is central to meditation. Techniques that reduce heart rate, such as deep and embryonic breathing, are widely used in mind-body practices for relaxation and stress management [Gilbert, 2003]. Applications like Calm and iBreathe use visual, audio, and haptic cues to guide deep breathing and mindfulness.

Biofeedback systems assist users in self-regulation by providing physiological information. The mindfulness installation *Sonic Cradle* transforms users' breathing rate into a soundscape, with qualitative results showing that feedback induces breathing harmony and a reduction in thought, but with a risk of over-relaxation [Vidyarthi and Riecke, 2013]. Studies of the virtual reality game DEEP show that heart rate variability feedback increases user relaxation and that the perception of self-efficacy reduces anxiety [Weerdmeester et al., 2017]. A study on the artwork *Cardiomorphologies* shows that rich information feedback helps participants link their thoughts and physiological state in real time [Muller et al., 2006].

Sound, traditionally from shamanic drums, is a known support for meditation [Flor-Henry et al., 2017]. Some digital meditation tools, such as Somadome, make use of binaural beats as they can impact relaxation and anxiety [Gao et al., 2014]. Other approaches use natural sounds such as waves, wind, or birdsong, which can be modulated in response to body signals [Ishii et al., 1998]. Compared with visual guidance, auditory guidance can induce a calmer state by reducing cognitive load, although it is less effective in decreasing breathing [Wongsuphasawat et al., 2012].

Light color and modulation can also affect body and mind. Colored light impacts breathing, heart rate, and stress response [Ross et al., 2013]. Warm-toned light can increase alertness, taking the center of the attention, whereas cool-toned light has the opposite effect and relates more to peripheral attention [Yu et al., 2018a]. A study with MoodLight [Snyder et al., 2015], however, notes some individual and cultural differences. Soft pulsing movements can help maintain users' attention while also allowing them to relax [Ross et al., 2013].

Multimodal feedback systems can induce a faster response to a stimulus than single indicators [Riggs et al., 2017]. Users of Soma Mat and Breathing Light, which combine light and heat indicators, reported an increased awareness of body changes and breathing [Ståhl et al., 2016]. The installation *Breathe with the Ocean* evaluated audio, haptic, and light biofeedback. Participants showed increased pleasure when combining feedback modes, although it was sometimes considered distracting. The most positive experiences were reported when multimodal feedback was modulated according to heart rate [Dijk and Weffers, 2010]. Further research suggests limiting feedback to two modalities to reduce risk of distraction and increasing users' understanding of their influence on the feedback loop [Sarter, 2006].

"Calm Technology" refers to systems that enter in and out of the periphery of the user's attention [Weiser and Brown, 1995]. In the *DeLight* study, users reported increased physical and mental relaxation with ambient light compared to explicit visual biofeedback [Yu et al., 2018a] while with RESonance, peripheral light was rated as easy to perceive [Yu et al., 2018b]. However, sudden changes in light can induce confusion and nervousness, so qualities such as subtlety and security are important [Höök et al., 2016].

Taoist temples, seen as a connector between traditional and contemporary culture [Liu and Li, 2018], provide a relevant context for linking digital installations with intangible cultural heritage. Other work in Taoist temples has taken a pedagogical approach to digitally preserving intangible

Fig. 1. Field observations in China, 2018. (©EPFL+ECAL Lab)

heritage [Mah et al., 2019] although wider debate promotes immersive installations to encourage affective experience and comprehension [Henchoz and Crank, 2018; Kenderdine et al., 2017].

3 DESIGN PROCESS

Our objective was to unite existing knowledge of digital meditation tools with the practice and culture of Taoism in an immersive digital installation. We therefore began our process in China, in the foothills of the holy Mao Shan mountain, to observe the traditional Taoist context (Figure 1). We practiced meditation and interviewed Taoist masters, disciples, and practitioners, making three key observations.

1. Taoism considers objects, practices, tradition, and philosophy as a whole.
2. A series of behaviors are performed to facilitate leaving the meditative state; these can be considered as a third, or exist, phase of meditation.
3. Taoists perform individual, but also group meditation, describing a positive impact of energy sharing.

Our first prototypes explored different feedback modalities with users (Figure 2). We observed that self-adaptation through biofeedback aided relaxation, reducing effort and disturbance. We also noticed a preference for light versus haptic feedback, and for natural over binaural sound. Some user suggestions reflected results from the *DeLight* project [Yu et al., 2018a] with the desire to distinguish different phases of the session and to combine light and sound. Finally, we decided on light as the main individual feedback modality, making use of its capacity to alternate between the periphery and center of attention, as with Calm Technology. Sound was targeted toward group feedback and set only at the periphery of the attention to avoid overload.

After a detailed comparison of physiological sensors for generating biofeedback evaluating impact, reliability, and comfort, we selected the following:

- galvanic skin response (GSR), or skin conductivity, to indicate modification of arousal and concentration during meditation [Anand, 2014]. The signal is obtained with two electrodes placed on two consecutive fingers.
- heart rate variability (HRV) to indicate pattern variation between meditation and resting and which has been used in meditation installations [Yu et al., 2018a]. The signal is detected on a fingertip using photoplethysmogram (PPG).
- breathing rate, the only autonomic nervous system element that can be consciously controlled and can trigger a relaxation response [Gilbert, 2003]. This is recorded with a breathing belt.

Fig. 2. Development of the deck and sensors, 2019. (©EPFL+ECAL Lab)

Although integrated in initial trials, we discarded electroencephalography as it was vulnerable to interference and the placement of receptors was too distracting to meditation. We also built an algorithm to take breathing rate through spectral breath purity.

To exist within a real Taoist temple, the final design had to combine practical and cultural requirements. We had to ensure freedom of practitioners' position and movement while maintaining the reliability of sensors and technical elements. The design also had to respect traditional Taoist philosophy and aesthetics such as ensuring a perception of vertical openness to connect earth and sky. Similarly, although our initial light feedback proposition was based on current literature, this was modified to reflect the colors of the Taoist "Dan Tian" energy points of the body.

4 FINAL DESIGN

The installation consists of three meditation decks in which practitioners sit and take part in a collective mediation session. The three decks match the number of immortal statues in the temple (Figure 3).

The round meditation deck has a low wooden platform and cushion for practitioners to sit on in a traditional cross-legged position (Figure 4). The upper light ring opens to allow practitioners to enter and leave. We designed a new breathing belt made of natural banana fiber by integrating a pressure sensor into a traditional Taoist garment. Practitioners also wear three rings and a fabric band that conceal skin conductance and heart rate sensors. These minimal and noninvasive sensors are connected to computers that control the individual and collective feedback.

The experience is based on a guided meditation session of 40 minutes for experienced practitioners and 30 minutes for novices. After a spoken introduction, practitioners receive light biofeedback in three phases. First, the practitioner relaxes and concentrates on their body. Feedback on their breathing is given by the breathing belt and the light ring is modulated based on galvanic skin response (GSR) to reduce arousal. During the middle phase, participants focus on inner observation supported by peripheral feedback on spectral breath purity. Finally, the installation facilitates leaving meditation by inducing sensations to recover consciousness of the body using breathing feedback modulated with GSR.

During the three phases of the session, biofeedback from all three practitioners extends into the room via a real-time visualization projection created with TouchDesigner (Figure 5). The animation

Fig. 3. The meditation decks at Ming Shan Temple, 2020. (©EPFL+ECAL Lab. Photo: Daniela & Tonatiuh.)

Fig. 4. The meditation deck with light ring, bespoke breathing belt, and finger sensors, 2019. (©EPFL+ECAL Lab. Photo: Daniela & Tonatiuh.)

is inspired by the notion of Qi energy that circulates in and between beings and traditionally takes the form of smoke or breath as well as the Taoist focus on harmony between human and nature. On leaving the deck, meditators can see a summary of their session. Then the visualization returns

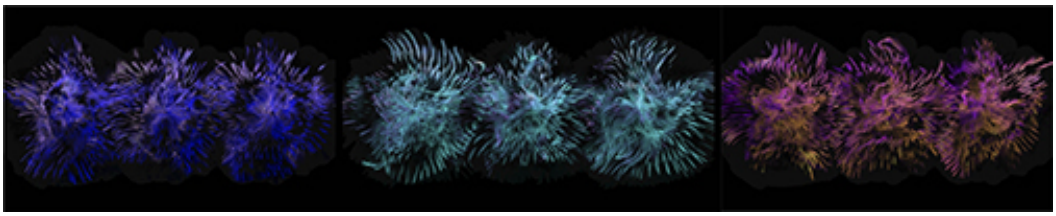

Fig. 5. Projected visualization of group biofeedback on the temple wall, 2020. (©EPFL+ECAL Lab)

to the smoke-like patterns, leaving a trace of the meditation in the temple. Collective meditation is supported by sounds inspired by traditional music generated by group biofeedback; using Ableton software, low frequencies are modulated by breathing rate and high frequencies by GSR.

5 EVALUATION AND MEASUREMENT

We designed an evaluation campaign to assess feedback preferences, impact on meditative state, collective meditation, and overall user experience of the installation.

We established four conditions of the installation to test feedback modalities: with/without light and with/without sound. Each participant experienced all four conditions in group sessions of three participants. Quantitative data, including pleasantness, meditation experience, and body sensations, were measured through questionnaires. Qualitative information was obtained through a group interview after each session.

Seventeen participants (aged 20–55, 59% female) completed the study. Recruitment didn't specify cultural meditation background. Participants didn't know each other and groups of three were assigned randomly. Eight participants stated that they used tools such as guided meditation or applications and four reported using meditation visualization techniques, with no significant correlation to age or frequency of practice.

Participants reported the sensors to be comfortable, showing no alteration of the meditation experience. Analysis with type of meditation practice (visualizations or no visualizations) revealed higher pleasantness ratings for the light condition ($M = 5.98$, $SE = .20$) compared to the condition without light ($M = 5.22$, $SE = .32$), $F(1, 13) = 4.78$; $p < .05$, $\eta^2 p = .27$. A marginally significant effect of light on profoundness of meditation was observed, $F(1, 13) = 4.62$; $p = .051$, $\eta^2_p = .26$, with participants in the light condition reporting deeper meditation ($M = 5.38$, $SE = .29$) compared to participants in the condition without light ($M = 4.24$, $SE = .39$).

Participants' attention to body sensations was positively influenced by light ($F(1, 14) = 4.29$; $p = .057$, $\eta^2 p = .24$) and sound ($F(1, 14) = 4.45$; $p = .053$, $\eta^2 p = .24$), both with marginally significant main effects. Light also has an effect on maintaining focus, with a difference mostly reported by participants familiar with tools. Regarding feeling connected to others during group meditation, sound was more positively perceived than visual feedback although not statistically relevant ($F(1, 16) = 1.79$; $p > .05$, $\eta^2 p = .10$). Figure 7 shows how the session combining sound and light was the favored condition.

Data from group interviews were coded into categories by two psychologists, followed by a methodology of comparison and resolution. We give key outcomes with occurrences in parentheses, although numbers shouldn't be compared statistically as they are taken from open interviews.

Lights were stated as supporting and enveloping. Blue was expressed as either pleasant or relaxing (8), and green was reported to help concentrate on the body (5). Although some participants were positive about color changes, for example, "the red at the end helps me come back," others (8) were distracted by them. Many considered the light to be too strong (14) and transitions too

Fig. 6. Evaluations in EPFL+ECAL Lab, 2020. (©EPFL+ECAL Lab)

abrupt. Several participants (11) said they didn't explicitly perceive the colors, although others (6) appreciated the link with breathing to help them concentrate (5).

Sound was found to be useful (10), enjoyable (9), and to facilitate meditation (8): "I felt very deep in the lower part of my body, and it was the deep sounds that carried me there, which was unusual for me." Some users didn't perceive the connection of sound with the body (7), but few mentioned it as disturbing (4). Silent sessions were considered more difficult and less enjoyable.

No negative comments were made about sharing biofeedback via the visualizations on the wall. However, the summary visualization generated some competitive thoughts (4): "I had a lot of unwanted thoughts because of the final projection, because I imagined what it would look like and it made me feel competitive."

Discussion on the overall experience showed that it was enjoyed (17) and provided strong sensations (14), with comments mentioning expansion and ecstasy: "I had an outer body experience and it was very difficult to come back at the end." The four sessions induce a learning curve effect (8). Sense of community was also mentioned, indicating the impact of collective feedback (6). Several people not using tools or visualization techniques reported that they didn't experience deep meditation and were distracted from their meditation (5).

6 BALANCING TECHNOLOGY AND TRADITION

The creation of this installation explored the relationship between technology, design, and ancestral culture in the context of a working Taoist center.

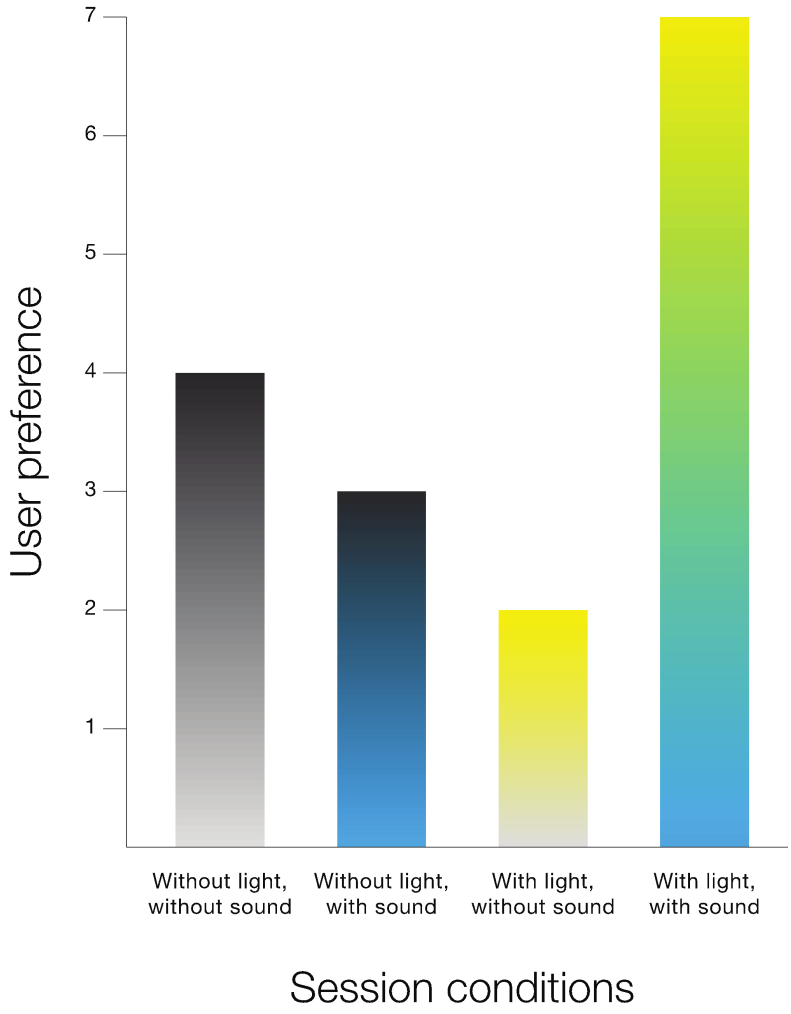

Fig. 7. User preference for session conditions. (©EPFL+ECAL Lab)

Design of the meditation deck and sensors linked technical and cultural requirements. Our modifications of the upper structure from a dome to a ring to culturally preserve the vertical connection between earth and sky were positively perceived. However, the compromise between literature and culture for the light colors caused some perception issues; strong warm colors during the first phase and abrupt transitions were often considered distracting, which is consistent with previous results [Yu et al., 2018a; Yu et al., 2018b].

Nonetheless, for informed practitioners, light feedback facilitated meditation by increasing positive emotions, reducing invasive thoughts, supporting deep meditation, and aiding concentration. Moreover, the light and sound condition was the most preferred scenario. Matching our hypothesis to design group feedback for peripheral attention, there were also indications that sound aided a feeling of collective meditation.

Our results showed a variation in perception depending on participants' personal meditation culture, although physiological differences like eyelid thickness on color discernment [Bierman et

al., 2011] could also explain this variation. This suggests that immersive multimodal biofeedback should be adjusted to its specific context and practitioners. The benefit of a learning effect reported over the four sessions opens perspectives on long-term impact of digital meditation supports.

The installation was adapted according to the results, and in November 2020, it opened for meditation sessions in the Ming Shan Temple. Applying the learnings in other contexts and increasing the number of meditation decks are under consideration, as the final design has a production cost estimated under $2000 depending on batch size.

7 CONCLUSION

Ming Shan Digital Experience shows how academic knowledge, a contemporary design approach, digital technology, and tradition can be combined to support the millennia-old practice of meditation. Evaluations of the installation show its ability to facilitate individual meditative practice and its potential to generate a collective feeling. Now installed in the Ming Shan Temple, the project will enable testing to continue with Taoist practitioners to better understand the effects of learning, time, and individual differences. The project can be seen as more than a meditation support, opening new perspectives for mixing digital and ancestral culture.

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