TechnoMysticism: Supporting Contemplative Meditation Practices using Technology. Exploring Design space, Guaging early User Perceptions

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INTRODUCTION

73% of Americans regularly experience stress symptoms []. The number in close to 90 % for the workplaces in China. Moreover, recent surveys have indicated how the global stress levels are still increasing []. Given these deteriorating conditions, the goal of *healthy living* has gained significant emphasis among the public []. The industry has responded with solutions like health tracking, activity tracking, biofeedback, etc. — these approaches however have been observed to have a limited, or no effect, on increasing stress []. Considering the failure of these state-of-the-art technology approaches, it makes sense to look back into our traditions, and to borrow historical methods that help us resolve this problem. Hence, contemplative meditation practices like *Chakra healing* [], and *Yoga* [] have become popular. These practices have been shown to alleviate the symptoms of various clinical conditions [] and provide time-tested formulae for healthy living. Through this exploration, we aim to support these practices through technology.

Meditation practices have received significant attention in research. Physiology studies of these practices on Tibetian experts (like monks) have helped uncover the underlying neural mechanisms behind these practices, that cause their desirable effects []. There is growing consensus within science on radical, new paradigms like mind-body connection [], embodied experience [], that have been central to these practices. That is the modern science is finally able to converge with ancient schools of thought where these practices emerged from and were shaped centuries back in time. Scientists have argued how mainstream science can benefit from understanding the rich science behind these practices []. Within Human computer interaction, meditation and mindfulness based research has recently become popular []. There efforts span across different media from smartphone applications, to VR and mixed reality systems []. Researchers have used BCI (brain-computer interfaces), breath sensing to enable interactive, biofeedback-based training for the user. However, we have just scratched the surface, and there is much more to be done. This field is still very young, calling rapid exploration in the near future.

Contemplative meditation practices can have a variety of procedures. For this paper, we focus on the practices that have a *visual imagery* element, and support them through immersive virtual reality. These practices require the user to imagine, form mental images of desired body conditions (like circulation of energies between the energy centres,) which then manifests in reality through the guided meditation process. We support this imagery through a third-person embodied experience in VR, i.e. the user sees the imagery on to his perceived body in the virtual world. Body ownership illusions have been achieved through VR and have observed to have significant perceptual, and emotional effects []. Interoception refers to the perceptual processes through which humans perceive the sensations from the inside of their bodies, like emotions or breath perception []. Showing desired changes (associated with the meditation practice) on the perceived virtual body creates a fake interoception channel that can prove to be more effective than mental imagery method. We aim to guage early user interventions regarding the effectiveness of this technology practice.

We chose four different contemplative meditation practices and designed supporting VR experience for all of them. Specifically, we referred to a guided session on each of the meditation practice (mostly popular YouTube videos,) and developed a VR experience in accordance with the script, as guided by the expert. Hence, the meditation procedure was retained, and the VR experience was developed around that. The four contemplative practices were selected to be mutually different — while still remaining within the defined scope of meditation based on mental imagery. Moreover, different practices included different input from the user like relaxation (sensed using electroencephalogram,) and breathing rate (sensed using a temperature sensor,) to mediate the meditation experience, as required by the script. Doing this allowed us to explore the design space focusing on different meditation styles and different technology interventions in a holistic manner. In this paper, we present the design space along with the user perceptions of all four experiences. In summary the contributions of this work are as follows.

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1. We present the design and technical implementation of supporting four different contemplative meditation practices in immersive VR experiences.
2. We present the user perceptions of individual meditative experiences, and consolidated discussion on the effects of technology-based intervention in this domain.
3. We present the design space of supporting contemplative meditation traditions through state-of-the-art technology including immersive VR, electroencephalogram sensing, breath sensing, and motion capture systems .

RELATED WORK

Our work is related to meditation research in HCI. Specifically, we refer to contemplative meditation practices. Finally, our design uses the body ownership illusion in Virtual reality.

Mindfulness and meditation focused research in HCI

Mindfulness and meditation based research has recently gained much importance in the HCI community. Recent sessions of major HCI conferences like CHI, UIST, and Ubicomp, have noticed multiple researchers submitting their initial proposals to work in this domain []. Mostly, researchers have been interested in gauging how technology can support and scaffold meditation practices or mindfulness based relaxation in general. Given their ubiquity, smartphones based applications have received much attention in this regard. Roquet at al. have started to evaluate different meditation apps on basis of parameters like cognitive strategy used, type of visual, audio stimulus from the smartphone, etc []. On similar lines, Ahmed et al. have evaluated the role of different senses (visual, audio, touch) in inducing a meditative state []. Derthick at al. have surveyed the use of information and communication technologies (ICTs) in this space []. Apart from smartphones, researchers have developed proof-of-concept demonstrations to indicate the potential of further interactive modalities like virtual reality [], augmented reality [] and dynamic physical environments [] to support meditation. Popular in these explorations is the use of brain-computer interfaces (BCI) systems to provide neurofeedback to enhance relaxation. For instance, in-the-moment concentration of the user is used to grow trees [] or to simulate jellyfish motion [] in the virtual world. Also interesting is the proposal of Delfa et al. who used BCI mental commands to control drones, simulating *meditaive movement* (MM) based practices []. Different from these environment related features, our simulations are focus on changes in the user's own body, visualized through third person perspective in VR. Also, though these prototypes have indicated interesting possibilities, this field is still very young, hence we haven't noticed any concrete systems or holistic explorations of the space. All of the work described above was presented in the Work in progress (WIP), video showcase sessions of the conferences. Through analysing a four different contemplative mediation practices, supporting them through a mix of technologies, we aim to present a design space focused in the given direction. Moreover, considering the young age of this focus within the HCI community, we refer to a variety of literature from the fields of psychology, neuroscience to ground our design decisions, and to set the foundation for future research.

Contemplative Meditation practices

This refers to the ancient meditation practices developed and preserved within the traditions of India and China like *Chakra healing* [], *Yoga* [], and *Quigong* []. Over time, these practices have seen an expansion in their geographical outreach and are today being practiced by enthusiasts all over the world []. More experienced practitioners educated regarding these practices share videos [] (like on *Youtube*) to enable them for amateur practitioners and beginners. These videos have millions of users, and hence increase the outreach of these practices further. These practices have been shown to alleviate the symptoms of various clinical conditions such as pain, emotional anxiety, distorted self-regulation, and even fatal diseases like Cancer []. Hence, researchers in contemplative neuroscience and neurophenomenology are looking to utilize the comprehensive empirical evidence for the positive effects of these practices, and the associated first-person experiences to advance mainstream science []. Supporting these practices is especially relevant to HCI considering the potential positive effects that they can create on the wider population.

Though the procedures associated with these practices can be very different, most of them share three main elements: mind relaxation, contemplation, and breath control []. Motion-based embodied contemplative practices (like Yoga and Quigong) have an additional element in form body motion []. We aim to support these elements through different technologies. Mind relaxation means to calm and clear the mind, which we check (support) through electroencephalogram (EEG) monitoring. Contemplation involves focusing attention on specific objects , such as images, affirmations, or the mind itself. For this project, we consider practices that involve focusing on *mental imagery* of the body and support it through Virtual Reality. In such practices, the user is required to form mental images of desired states of his body (like golden colored *Qui* energy flowing up the spine) which then manifest in the process, results of the meditative practice. We propose the novel method of showing these body states through a third-person embodied experience in VR. Breath control plays a significant role in how these images transform over the duration of the practice — we support this experience through real-time breath sensing. Finally, the motion element in motion-based contemplative practices is supported through motion capture using Kinect.

Chakra healing deals with balancing the energies of the seven energy centres (*Chakras*) in the human body []. The seven chakras are arranged across the upper body, along the spine, from the pelvic bone to the crown (top of the head). These chakras constitute the indic central nervous system as defined in the Buddhist and the *Hindu tantra* traditions []. A typical chakra healing practice involves the user focusing on the different chakras one after the other, observing the energies that they eminate at the respective body locations, and to balance them using guided recitations and breath control []. *Quigong* is an ancient chinese contemplative meditation practice of coordinated body posture and movement, breath control, which is used for purposed of health, spirituality and martial arts training []. Essentially, Quigong is about cultivating the '*qui*,' or the life energy. A typical Quigong session includes the user performing a set of movement sequences, and contemplating

on, forming mental imagery of the corresponding motion dynamics of the 'qui' []. As established above, we use VR to assist the contemplation process of the chakra healing, Quigong practices. That is, instead of having to imagine the energies from the chakras, movement of 'qui' energy, the user sees those happening in what he perceives is his body (in VR). The user actually feels that the changes are real, and immediately develops a sense of interoception.

Scientific basis for Contemplative Meditation practices

The physiological studies of meditation enabled the understanding of the neural correlates associated with these practices []. The study of the brain of Tibetian-trained expert meditators using neuroimaging methods showed evidence for the meditation-induced increases in the cortical thickness of the preforontal cortex area of the brain, that helped explain some of the positive effects of mindfulness meditation like socio-emotional self-regulation, etc. []. Most of contemplative meditation practices described above are based on two paradigms: mind-body connection — that the mind and the body are united, and can affect one another,— and embodied experience — that the experience of one's self in the world does not solely emerge from the neural activity of the brain, but involves a complex interplay of the brain, body and the interactions with the environment []. There are growing traditions in science to support both of these paradigms []. An understanding of these traditions enabled us to make better informed design choices regarding our VR experiences. Seminal work by Varela et al. [] and the closely related "grounded theory of cognition" [] laid the foundations of embodied cognition. One result of this was the understanding of emotions as the mental experiences of the body states []. Recently, Lauri et al. published their high impact work on body maps of different emotions, developed on basis of comprehensive self reports []. We utilized the map associated with anxiety to represent the emotion in the (virtual) body of the anxious users, who then engaged in our virtual mediation experience to treat the same. Similarly, Loizzo et al. studied the chakra system and established its links to the central nervous system []. His account helped us ground the representation of the system as manifested in our VR experiences.

Body ownership illusion in Virtual Reality

Body ownership illusion (BOI) is one of the major feet achievable through virtual reality. BOI's put the user into the perceptual state of him embodying a virtual avatar, creating the feeling that the body is "mine." Such illusion has been studied to induce strong cognitive and behavioral effects like altering the perception of size and shape of user's own body or making him empathetic towards other people (whose virtual body the user embodies). This illusion has been studied for many such applications in the field of Psychology and Neuroscience. Within HCI, Jun et al. have recently utilized this illusion to effect user emotions through VR. We use body ownership illusion as a novel method of providing the user with feedback about the changes in his body as incurred by the contemplative mediation practice that he participates into.

BOI have been designed in a first-person or a third-person perspective (1PP and 3PP). In 1PP, the user body is directly superimposed on to the virtual body. Body tracking techniques are employed to map the avatar' body movement with the user, hence giving real-life like experience. In 3PP however, the user sees the avatar (with similar mapping of the body movements) in the virtual world in front of his physical body, simulating an *out-of-body* presence. The experience is similar to looking oneself in the mirror and has been observed to be as effective as 1PP []. In our scenario, we prefer the 3PP owing the greater body visibility that is affords. The user is able to view his complete body and his peri-personal space (space around the body), in comparison only the lower body and limbs in 1PP. This enables us to provide visual feedback for the meditation-induced body changes (like embodied representations for changing emotions) through our experiences.

Researchers have explored visuotactile and visuomotor triggers to induce Body ownership illusions []. Kilteni et al. evaluated the relative efficiency of these techniques and found them both to be effective in inducing BOI. We implement visuomotor technique by using motion capture systems like HTC Vive HMD and Kinect. Implementing visuotactile technique requires the presentation of external tactile stimuli on to the user (corresponding to visual stimuli in VR) which usually requires human workers, hence imposing limits on the scalability. Moreover, in some experience designs, we support movement mapping of limited body parts (neck and upper limbs,) only simulating the user in a sitting position. Researchers have established that mapping neck movement is perceptually more significant than the limbs and is sufficient to induce body ownership and illusion.

APPLICATION EXAMPLE: CHAKRA HEALING

The user settles down in cross-legged posture, enters the VR environment. He finds himself sitting eye-to-eye in front of a virtual body sitting cross-legged, there is soothing ambient music. The user looks around to explore the virtual space, the neck of the virtual moves accordingly. User is triggered to move his upper limbs, start to move them; the virtual body follows. This visuomotor correspondences establishes the out-of-body embodied experience; the user feels "its my body." The guided meditation session starts. User is asked to take deap breaths, feel the sensation of the air going in, energizing the body, and going out. User sees this in his virtual body. A breath goes in, his body lights up, the breath goes out. There is not much in the environment to distract the user, he goes on. The user is asked to focus on his bottom most chakra, sitting at the lowest point of his spine. He sees it light up in his (virtual) body, emitting bright red light. He uses his breath to charge up the chakra; the red light becomes brighter with each breath that he takes in ..... goes on