LOOP Meditation: Enhancing Novice's VR Meditation Experience with Physical Movement

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ABSTRACT

Virtual reality (VR) and associated technologies have rapidly grew, creating new opportunities for improving mental health. In order to provide an immersive and concentrated meditation experience, this paper offers the idea of VR-assisted meditation, which integrates the advantages of VR technology with mindfulness techniques. The suggested technique, which is known as LOOP Meditation, is mainly aimed toward novice meditators and places a strong emphasis on the value of movement and breath awareness when meditating. Existing VR experiences and meditation applications sometimes ignore the value of including physical movement, which can improve mindful body sensations and maintain interest. By creating a software that incorporates body movement and breath sensing into virtual reality surroundings, LOOP Meditation addresses this gap. The LOOP Meditation design and implementation are examined in this paper along with its possible advantages and consequences for people looking to develop their meditation practice. A pilot research comparing the efficacy of this strategy to conventional meditation techniques is offered. The study's findings add to the expanding body of knowledge on VR-assisted meditation and demonstrate how it may have a positive effect on mental health.

CCS CONCEPTS

• **Human-centered computing** → *Usability testing*; **Virtual reality**.

KEYWORDS

Virtual reality, interaction design, meditation, wellness

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1 INTRODUCTION

Meditation, or mindfulness, is a effective practice for stress management, attentional focus, and mental calmness, often involving the regulation of breathing [16]. In recent years, the rapid development of virtual reality (VR) and related technologies has opened up new possibilities for enhancing people's mental well-being. VR is increasingly being utilized in various domains, such as exposure treatment (VRET), pain management, and stress reduction [8]. The integration of meditation with virtual reality environments (VRE) has gained significant attention and has been substantiated by numerous studies as a means of enhancing mental well-being [26].

For novice meditators, mastering the art of meditation can be challenging, as they often struggle to remain engaged and sustain their focus during meditation [3, 12]. Along with offering visual and audible instruction, increased physical interaction with the virtual reality environment can further boost the user's immersion. Furthermore, body movement has been proved can enhance the benefits of both physical sensation and mindfulness practices [19]. However, the majority of the popular meditation applications [1,2] on the market primarily focus on visual and auditory stimulation, frequently miss the value of including body movement when meditating and lack interactivity [5].

To emphasize the role of physical movement in meditation, we propose LOOP Meditation, a novel VR meditation system specifically tailored for novice meditators. In order to create a more immersive and concentrated meditation experience, our VR meditation system incorporates physical movement interacting with virtual reality environment and breath perception as important components.

In this paper, we explore the design and implementation of LOOP Meditation, and discuss its potential benefits and implications for novice meditators seeking to cultivate a deeper meditation practice. We also present the results of a pilot study evaluating the effectiveness of this approach in comparison to traditional meditation methods. Ultimately, we anticipate that our research will contribute to the growing body of knowledge on VR-assisted meditation and its potential to positively impact mental well-being.

[1] https://www.tripp.com/
[2] https://www.oculus.com/experiences/quest/2406880882663555/

2 RELATED WORK

2.1 Meditation Types and Movement

Meditation, or mindfulness, by using a physical sensation like controlling breathing, can help people manage stress, focus attention and cultivate mental calmness [16]. According to psychological processes, meditation practices can be classified into at least two categories by Lutsz et al. [15], including *focus attention* (FA) meditation and *open monitoring* (OM) meditation. FA meditation entails voluntarily focusing attention on a specific object or breathing in a sustained manner [23], OM meditation involves monitoring the content of experience without focusing on any explicit object momentarily, primarily as a means to recognize the nature of emotional and cognitive patterns [23]. For beginners, generally they can use FA mediation technique [13, 14, 25], only those are experienced meditators can master OM meditation. Tsai et al. indicated that short-term FA meditation can promote a meditator's ability to ignore surrounding disturbances and improve concentration [24]. For novices, however, mastering the art of meditation can be challenging, as it is common for them to become disengaged and lose focus [3, 12], resulting in a lack of sustained meditative states. Meditation movement [10] is a term, which is defined by Larkey et al., referring to combine movement with meditative attention to body sensations. Traditional meditation movement forms include Chinese Qigong and Tai Chi, as well as some forms of Yoga and other Asian practices, which have been proved can enhance the benefits of both physical exercise and mindfulness practices [19].

2.2 Meditation in Virtual Reality

Meditation with VR has been proved in abounding studies can enhance human mental well-being [26]. The immersive nature of VR can enhance engagement and support attention to sensations during meditation, while also reducing external distractions [6, 17]. The experience of VR-based meditation in current literature mainly includes visual and audio guidance [6] and mainly have less active user input (user interaction with the virtual environment relies primarily on biosignals, such as respiratory rate [7, 18] or brain activity [1, 9]).

For example, Patibanda et al. [18] designed *Life Tree* transform respiration into visualised tree growth processes. Prpa et al. [20] enhanced the audio and visual cues in a virtual environment mapping to the user's breathing patterns. *JeL* promoted by Stepanova et al. [21] constructs the growth of a visual cue (a coral-like structure) in biofeedback virtual environment using two-person synchronised breathing signals. VR system DYNECOM [7] uses incorporated respiration and brainwave-based biofeedback to provide users with real-time visualizations of breathing rate and electroencephalograph (EEG) frontal asymmetry levels. VR meditation tool named RelaWorld [9] uses neurofeedback which measures brain activity through EEG, and discuss direct observation of cognitive processes during meditation, and can measure the level of relaxation of the users. VR meditation system promoted by Amorse et al. [1] also used an EEG headband to identify meditation states.

While effective, existing VR meditation systems are designed with a focus on specific components of meditation, especially for the bio-signal input interacting with the virtual reality environment. According to a pilot study [5], VR meditation systems may not be as popular due to their general lack of interactivity. Body sensation and interaction, however, is also a vital component that is often overlooked in VRE design. Instead of enhancing interaction, several pervious work focus on body scanning by creating avatars in VRE [7, 9]. Futhermore, existing VR meditation systems that rely on expensive external devices can be difficult to use without expertise. There has been limited exploration of how VR can be utilized to guide meditation using a single mobile device, without the need for biofeedback device. By focusing on the relationship between breathing and body sensation, VR meditation system can provide a more accessible and immersive experience for users.

In our study, we used the FA (focused attention) meditation method to speed up the development of novice meditators. This method places a strong emphasis on shifting one's attention back to a particular experience, especially persistent attention to breathing [4, 11, 22]. The Tai Chi meditation method, which encourages the integration of the mind and body through slow movements, serves as inspiration for the inclusion of slow circular body movement in our VR meditation system. The most natural way to engage with the VR environment is through hand movement because of the features of VR headset and controllers. We emphasize hand involvement when it comes to body sensation. Therefore, to create a concentrated and immersive meditation experience, our VR meditation system, LOOP Meditation, integrates circular hand movements, breath awareness, and VR technology. LOOP Meditation aims to boost physical engagement in VR during meditation by concentrating on hand movements and including breath perception, as well as to improve general well-being by combining the advantages of VR and meditation.

Based on the discussion above, we summarize our research questions as follows:

(1) How does integrating body movement with breath perception in VR meditation impact the emotional regulation, body awareness, and overall mental health of novice meditators?
(2) How does the complexity level of body movement in VR meditation influence the meditation experience?

3 SYSTEM OVERVIEW

3.1 Hardware and Setup

The system's hardware setup consists of a computer, an Oculus Quest2 headset display device. The virtual reality experience was delivered through Oculus Quest headset (v2022) and Oculus Touch hand controller. To create 3D models, we utilize Unity3D (v2021.3.15f1) [3] and Adobe Photoshop [4], supplemented by assets obtained from the Unity3D asset library. Furthermore, the main program is executed within the Unity3D framework.

3.2 Design of the Virtual Environment

LOOP Meditation is centered around a serene natural setting, creating an immersive environment that promotes relaxation. This setting features a lakeside backdrop that strikes a balance between

[3] https://Unity3d.com
[4] https://adobe.com.

Figure 1: Overview of the scene elements and visualizations.

wilderness and familiarity. Each session begins with a demonstration of two types of physical movement. The meditative environment incorporates elements such as small balls moving in circular motion on the lake, a forested backdrop surrounding the lake, and breath cues (Breath in/out) displayed in a regular pattern above to guide attention and facilitate readability.

We add calming piano music that evokes the atmosphere of nature, masking any background sounds from the laboratory, to enhance immersion. This is inspired by the work of Andersen et al. [2] that explores the use of audio during meditation and the result indicates that either a sole auditory guide or a combination of relaxing sound with virtual objects can help users concentrate better. The scene layout is illustrated in Figure 1. Additionally, a forest background is added around the platform to direct participants' focus and discourage excessive exploration, creating a sense of enclosure and intimacy. The design choice aims to provide a feeling of safety while still allowing an open view of the sky to prevent claustrophobic anxiety. Intentionally keeping the height of the trees suggests that one can easily exit the environment if needed, which might lessen the oppressive feeling that can result from enclosed spaces.

3.3 Different Types of Physical Movements and Interaction

The user interacts with the virtual environment by using the controller ray to control the blue ball in the environment as it moves down the set track. A white ball moving along a fixed track appears at eye level with the user as a rate cue for later controlling the ball's movement. To enhance the meditation experience, LOOP Meditation incorporates two distinct track as visual cues that encourage body movement awareness and engagement, as illustrated in Figure 2:

Infinity loop. As part of the immersive environment, LOOP Meditation utilizes motion cues represented by the "infinity loop" symbol. This visual cue, often associated with continuous flow and balance, serves as a guiding reference for participants to synchronize their movements.

Ellipses. Ellipses is another form of visual cues, reducing the complexity of body movement. By focusing their attention on these ellipses, participants are prompted to engage in specific body movements or follow a predetermined sequence, fostering a heightened

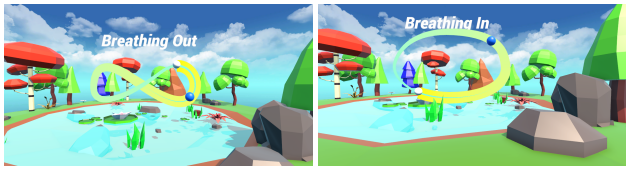

Figure 2: Two distinct visual cues that encourage body movement awareness and engagement: (a) Motion cues using "infinity loop". (b) Visual cues using ellipses.

sense of body awareness and promoting a more immersive meditation experience.

4 EXPERIMENTAL EVALUATION

4.1 Participants

We recruited a total of three participants (one male and two females) for our study on LOOP Meditation. These individuals were selected based on their passion for meditation and their status as novice meditators. To ensure a comprehensive understanding of the participants' backgrounds, an online recruitment survey was administered prior to the study. This survey aimed to gather information on various aspects such as the participants' familiarity with the meditation process and their stress levels. For a detailed overview of the participants' backgrounds and proficiency, please refer to Table 1.

Table 1: Participants' Background Information and Stress Levels

ID	Gender	Age	Familiarity	Stress Level[1]
P1	Female	22	Low	Low
P2	Male	23	Moderate	Moderate
P3	Female	22	Low	Moderate

[1] Stress levels based on self-reported assessment.

4.2 Task and Procedure

Participants in the study were exposed to three distinct meditation environments: one featuring only textual cues, another with textual cues and infinite loop images, and a third with textual cues and elliptical images. By offering these varied environments, we aimed to explore the impact of different visual cues on the participants' meditation experiences. Each participant performed a three-minute meditation process. To ensure consistency across participants, the study employed a standardized computer setup for accessing the VR content. This approach helped maintain a controlled and uniform environment throughout the tutorial sessions. Additionally, the experimental sequence was counterbalanced to minimize potential subjective biases stemming from the order of presentation. After the meditation process, we performed a semi-structured interview. The interview took place in the same room, providing a consistent environment for data collection. The interview questions include participants' general impressions of the meditation environment, their experiences with different forms of physical movement, and

their evaluation of the advantages and disadvantages of the three meditation modalities.

5 EVALUATION & DISCUSSION

The evaluation of the system's usability and the VR meditation experience primarily relied on semi-structured interviews conducted with the participants, the qualitative insights obtained from the interviews provide valuable subjective perspectives on the usability and user experience of the system.

5.1 Number of distractions

In the context of the infinity loop format, two participants reported experiencing fewer distractions compared to other modalities. Participant 2 specifically mentioned that the circular motion of the infinity loop allowed for more wrist oscillation, enabling them to maintain focus (*P1: "the circle would be on the single side and the infinity loop would allow for more wrist oscillation and allow me to focus more; "*). However, one participant noted that while the circle and loop patterns were more conducive to concentration than text cues, the difference was not significant for him. He emphasized the importance of regulating his breathing during meditation and felt that the visual stimuli had minimal impact (*P2:"I try to keep my breathing rate during meditation and the images do not have much impact. "*).

5.2 Shape design of visual cues

The infinite loop pattern received positive feedback from both participants. However, there were also some drawbacks mentioned. Participant 3 pointed out that the repetitive mechanical motion of the loop could lead to a sense of getting lost or fixating on the visuals. Participant 1 expressed the desire for a wider variety of pattern designs to enhance the meditation experience, suggesting that while the current pattern was interesting, additional patterns would encourage them to spend more time in the virtual environment (*P1: "I think this pattern is interesting, but if there are other more patterns I can stay longer in the environment."*). The circular pattern design was described as monotonous and even hypnotic by some participants (*P2:"it feels like hypnosis."*).

5.3 Overall meditation experience

Overall, all three participants provided positive reviews of the VR meditation experience, noting its effectiveness in reducing stress levels and aiding their focus on breathing. Participants also offered suggestions for enhancing the VR environment design, such as incorporating different lighting conditions and scenarios. One participant mentioned that the infinity loop pattern reminded them of the yin and yang taiji diagram, and they expressed interest in having the option to choose between day and night scenes within the virtual environment (*P1:" The infinity loop reminds me of a yin and yang taiji diagram, so it would be nice to have day and night scenes to choose from. "*).

6 LIMITATION & FUTURE WORK

6.1 More Pattern Design and Scene Design

To enhance the VR meditation experience, future work should focus on expanding the range of pattern designs and scene options available to users. Incorporating a wider variety of visually appealing patterns can provide a greater sense of novelty and engagement during meditation sessions. Researchers can explore different geometric shapes, mandala designs, or other visually stimulating patterns to cater to diverse user preferences. Additionally, offering a variety of scene designs, such as serene natural landscapes or calming indoor settings, can further enhance the immersive and relaxing atmosphere of the VR meditation environment. By providing more pattern and scene options, users can have a personalized and enriching meditation experience.

6.2 Allow Users to Choose their Own Meditation Duration

To accommodate individual preferences and meditation goals, future iterations of the VR meditation system should allow users to customize the duration of their sessions. Providing the flexibility for users to select their desired meditation duration, whether it be a short session for busy individuals or a longer session for more in-depth practice, can enhance user engagement and satisfaction. This customization feature can be integrated into the VR meditation program, allowing users to set their preferred duration before beginning the session. By allowing users to choose their own meditation duration, the system can cater to different schedules and preferences, fostering a more tailored and effective meditation experience.

7 CONCLUSION

Through the evaluation of three different meditation modalities, namely textual cues, infinite loop, and elliptical shape, valuable insights were gathered regarding participants' perceptions and experiences. Overall, participants provided positive reviews of the VR meditation experience, noting its ability to alleviate stress and promote attention to breathing. They also offered suggestions for further enhancing the VR environment, such as incorporating different lighting conditions and scenarios to create a more immersive and personalized meditation space. The study had some limitations, including a small sample size and reliance on subjective evaluations. Future work should address these limitations by conducting larger-scale studies and incorporating objective measurements to complement the qualitative feedback.

In conclusion, the findings of this study demonstrate the potential of LOOP Meditation in enhancing the meditation experience for novice practitioners. The incorporation of body movement and breath perception, along with the design of visual cues, contributes to a more engaging and immersive meditation environment. By further refining and expanding the system based on user feedback, LOOP meditation has the potential to become a valuable tool in promoting mental well-being and personal growth.

REFERENCES

[1] Judith Amores, Robert Richer, Nan Zhao, Pattie Maes, and Bjoern M Eskofier. 2018. Promoting relaxation using virtual reality, olfactory interfaces and wearable

EEG. In *Proceedings of IEEE International Conference on Wearable and Implantable Body Sensor Networks*. IEEE, 98–101.

[2] Thea Andersen, Gintare Anisimovaite, Anders Christiansen, Mohamed Hussein, Carol Lund, Thomas Nielsen, Eoin Rafferty, Niels C Nilsson, Rolf Nordahl, and Stefania Serafin. 2017. A preliminary study of users' experiences of meditation in virtual reality. In *Proceedings of IEEE Virtual Reaility*. IEEE, 343–344.

[3] Tracy Brandmeyer and Arnaud Delorme. 2018. Reduced mind wandering in experienced meditators and associated EEG correlates. *Experimental Brain Research* 236 (2018), 2519–2528.

[4] Cortland J Dahl, Antoine Lutz, and Richard J Davidson. 2015. Reconstructing and deconstructing the self: cognitive mechanisms in meditation practice. *Trends in Cognitive Sciences* 19, 9 (2015), 515–523.

[5] Andrew T Dilanchian, Ronald Andringa, and Walter R Boot. 2021. A pilot study exploring age differences in presence, workload, and cybersickness in the experience of immersive virtual reality environments. *Frontiers in Virtual Reality* 2 (2021), 736793.

[6] Nina Döllinger, Carolin Wienrich, and Marc Erich Latoschik. 2021. Challenges and opportunities of immersive technologies for mindfulness meditation: a systematic review. *Frontiers in Virtual Reality* 2 (2021), 644683.

[7] Simo Järvelä, Benjamin Cowley, Mikko Salminen, Giulio Jacucci, Juho Hamari, and Niklas Ravaja. 2021. Augmented virtual reality meditation: Shared dyadic biofeedback increases social presence via respiratory synchrony. *ACM Transactions on Social Computing* 4, 2 (2021), 1–19.

[8] Shaun W Jerdan, Mark Grindle, Hugo C Van Woerden, and Maged N Kamel Boulos. 2018. Head-mounted virtual reality and mental health: critical review of current research. *JMIR Serious Games* 6, 3 (2018), e9226.

[9] Ilkka Kosunen, Mikko Salminen, Simo Järvelä, Antti Ruonala, Niklas Ravaja, and Giulio Jacucci. 2016. RelaWorld: neuroadaptive and immersive virtual reality meditation system. In *Proceedings of the 21st International Conference on Intelligent User Interfaces*. 208–217.

[10] Linda Larkey, Roger Jahnke, Jennifer Etnier, and Julie Gonzalez. 2009. Meditative movement as a category of exercise: implications for research. *Journal of Physical Activity and Health* 6, 2 (2009), 230–238.

[11] Tatia M. C. Lee, Mei-Kei Leung, Wai-Kai Hou, Joey C. Y. Tang, Jing Yin, Kwok-Fai So, Chack-Fan Lee, and Chetwyn C. H. Chan. 2012. Distinct Neural Activity Associated with Focused-Attention Meditation and Loving-Kindness Meditation. *PLOS ONE* 7, 8 (08 2012), 1–11. https://doi.org/10.1371/journal.pone.0040054

[12] Daniel B Levinson, Jonathan Smallwood, and Richard J Davidson. 2012. The persistence of thought: Evidence for a role of working memory in the maintenance of task-unrelated thinking. *Psychological Science* 23, 4 (2012), 375–380.

[13] Dominique P Lippelt, Bernhard Hommel, and Lorenza S Colzato. 2014. Focused attention, open monitoring and loving kindness meditation: effects on attention, conflict monitoring, and creativity - A review. *Frontiers in Psychology* 5 (2014), 1083. https://doi.org/10.3389/fpsyg.2014.01083

[14] Antoine Lutz, Julie Brefczynski-Lewis, Tom Johnstone, and Richard J Davidson. 2008. Regulation of the neural circuitry of emotion by compassion meditation: effects of meditative expertise. *PloS One* 3, 3 (2008), e1897.

[15] Antoine Lutz, Heleen A Slagter, John D Dunne, and Richard J Davidson. 2008. Attention regulation and monitoring in meditation. *Trends in Cognitive Sciences* 12, 4 (2008), 163–169.

[16] Ramesh Manocha. 2000. Why meditation? *Australian Family Physician* 29, 12 (2000), 1135–1138.

[17] Melissa Miller, Divya Mistry, Rakesh Jetly, and Paul Frewen. 2021. Meditating in virtual reality 2: Phenomenology of vividness, egocentricity and absorption-immersion. *Mindfulness* 12 (2021), 1195–1207.

[18] Rakesh Patibanda, Florian'Floyd' Mueller, Matevz Leskovsek, and Jonathan Duckworth. 2017. Life tree: understanding the design of breathing exercise games. In *Proceedings of the Annual Symposium on Computer-Human Interaction in Play*. 19–31.

[19] Peter Payne and Mardi A Crane-Godreau. 2013. Meditative movement for depression and anxiety. *Frontiers in Psychiatry* 4 (2013), 71. https://doi.org/10.3389/fpsyt.2013.00071

[20] Mirjana Prpa, Kıvanç Tatar, Jules Françoise, Bernhard Riecke, Thecla Schiphorst, and Philippe Pasquier. 2018. Attending to breath: exploring how the cues in a virtual environment guide the attention to breath and shape the quality of experience to support mindfulness. In *Proceedings of the 2018 Designing Interactive Systems Conference*. 71–84.

[21] Ekaterina R Stepanova, John Desnoyers-Stewart, Philippe Pasquier, and Bernhard E Riecke. 2020. JeL: Breathing together to connect with others and nature. In *Proceedings of the 2020 ACM Designing Interactive Systems Conference*. 641–654.

[22] Mattie Tops, Maarten AS Boksem, Markus Quirin, Hans IJzerman, and Sander L Koole. 2014. Internally directed cognition and mindfulness: An integrative perspective derived from predictive and reactive control systems theory. *Frontiers in Psychology* 5 (2014), 429.

[23] Fred Travis and Jonathan Shear. 2010. Focused attention, open monitoring and automatic self-transcending: categories to organize meditations from Vedic, Buddhist and Chinese traditions. *Consciousness and Cognition* 19, 4 (2010), 1110–1118.

[24] Min-Hui Tsai and Wei-Lun Chou. 2016. Attentional orienting and executive control are affected by different types of meditation practice. *Consciousness and Cognition* 46 (2016), 110–126.

[25] David R Vago and David A Silbersweig. 2012. Self-awareness, self-regulation, and self-transcendence (S-ART): a framework for understanding the neurobiological mechanisms of mindfulness. *Frontiers in Human Neuroscience* 6 (2012), 296.

[26] Xian Wang, Xiaoyu Mo, Mingming Fan, Lik-Hang Lee, Bertram E Shi, and Pan Hui. 2022. Reducing Stress and Anxiety in the Metaverse: A Systematic Review of Meditation, Mindfulness and Virtual Reality. *arXiv preprint arXiv:2209.14645* (2022).