A Soundscape Interaction System for Enhancing Mindfulness While Running

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1 Introduction

Running meditation is a form of mindfulness training, where the act of running provides a rhythmic meter for attention focus (De Petrillo et al., 2009). Existent mobile applications mainly support mindfulness training while sitting and walking, and few applications use real-time feedback technology to support running meditation training. This research aims to develop an interactive soundscape system to assist running meditation by providing a suitable real-time audio feedback according to the runner's biodata such as heart rate and cadence.

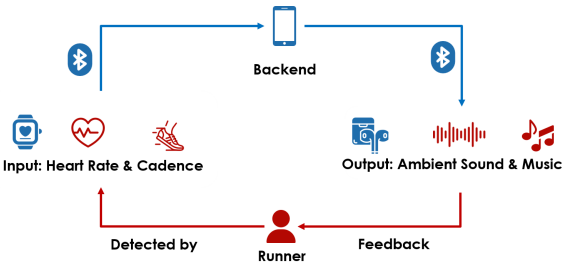

Figure 1. Overview of the system design

To achieve this goal, we designed a running meditation framework based on the Attention Regulation Framework (ARF) (Niksirat et al., 2019) to build a closed-loop attention regulation process from three aspects of detection, feedback, and regulation during running. We developed a design case to implement the interaction design of kinetic mindfulness practice (**Figure 1**). Finally, we designed an experiment to evaluate the efficiency of the mindfulness running soundscape system.

2 System Design

The design of the inner feedback closed-loop comes from traditional mindfulness activities such as Tai Chi. It requires the user to focus on their body sensations such as pace and breath while performing a continuous, soothing, rhythmic running exercise. At the same time, this activity can be an attention anchor to help the user regulate their attention.

Based on the users' biodata (heart rate, cadence), the system provides appropriate audio feedback (music, ambient sounds, and tempo sound effects). The system will monitor whether the user is doing continuous, soothing, rhythmic running exercise by the user's real-time heart rate and cadence while running. Changes in heart rate are feedback to the user in the form of volume, while changes in cadence correspond to changes in ambient sound content (**Figure 2**). Technology feedback can help users better engage in the Inner feedback. This synergized interaction design allows two kinds of feedback to support and enhance each other.

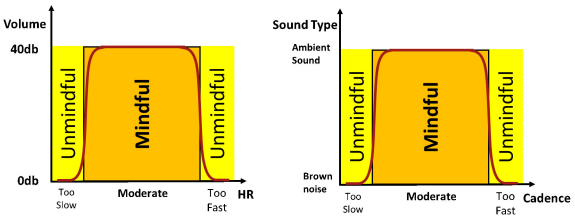

Figure 2. Real-time audio feedback design for maintaining regular movement

3 Experiment Design

The experiment included 24 university students and staff members (4 females) aged 20-44. The conditions were between subjects, comparing two conditions: Using system vs not using system. The training was within-subjects, comparing pre-training with post-training states. We evaluated the effect of training in four indexes: body awareness, focus, motivation, and mindfulness.

4 Results

We assume that our system can effectively assist users in running meditation in the short-term regarding body awareness, exercise motivation, and focus. Long term-training can achieve mindfulness state. In the following subsections, we report significant results.

4.1 Exercise Performances

In this experiment, the 20-minute running meditation process consisted of three sessions. As shown in **Figure 3**, the heart rate performance of the experimental group can be summarized into three types: (1) Liner Growth: Some participants' (n=3) heart rate kept increasing while fast walking, although the ca-

dence was generally constant. (2) Constant: Some participants (n=6) kept fast walking at a constant speed, and their heart rate and cadence remained stable. (3) Square Wave: Some participants (n=3) used a fast walking-jogging-fast walking strategy. Both heart rate and cadence data clearly showed a trend of low-high-low and remained stable within each session. Compared to the experimental group, the exercise data of the control group (n=10) showed significant irregularity due to the loss of system regulation.

Figure 3. Heart rate and cadence data performance.

4.2 Body Awareness

We used the Multidimensional Assessment of Interoceptive Awareness (MAIA) questionnaire to test participants' body awareness before the beginning and after the end of the running meditation training. Excluding items unrelated to our research goals, we focus on two measures in this questionnaire: attention regulation and self-regulation.

Attention regulation means the ability to sustain and control attention to body sensations. Test for comparison of means showed that the post-test score of the experimental group increased by 0.49 compared with the pre-test score, which was greater than that of the control group (0.32).

Self-regulation means the ability to regulate distress by attention to body sensations. Test for comparison of median showed that the post-test score of the experimental group increased by 0.50 compared with the pre-test score, which was much greater than that of the control group (0.13).

4.3 Exercise Motivation

We used the Intrinsic Motivation Inventory (IMI) questionnaire to test participants' motivation for running meditation in the experimental and control groups after the end of the running meditation training. Test for comparison of means shows that the score of the experimental group (5.42 $\pm$ 0.9) is higher than the score of the control group (4.83 $\pm$ 0.96) on interest/enjoyment. And the score of the experimental group (5.76 $\pm$ 1.26) is higher than the score of the control group (5.02 $\pm$ 1.38) on value/usefulness. This shows that users think our system improves the motivation of running meditation and is effective in assisting running meditation activities.

4.4 Attention Focus

We used the Measure of Attentional Focus (MAF) questionnaire to test participants' attention focus while running after the end of the running meditation training. The MAF questionnaire consists of six questions, each of which represents a part of attention focus strategies. The result presents that in terms of bodily sensations (heart rate, breathing rate, muscles, fatigue, pain, sweating, cramps), the data of the control group (20.0%) is significantly higher than that of the experimental group (15.8%). In terms of task-relevant thoughts (strategies, goals, pace, injury concerns, thoughts about time), the data of the experimental group (26.7%) is significantly higher than that of the control group (19.1%). In addition, the participants in the experimental group assigned significantly higher attention to task-relevant thoughts than to other aspects.

5 Conclusion

Through our study, we found our system successfully guided the participants in the experimental group to keep a regular and constant pace during running meditation. At the same time, participants' body awareness and attention regulation were enhanced. The interactive soundscape also improved users' enthusiasm for running meditation. However, because the training time is too short, the daily mindfulness performance of participants did not change significantly. Overall, our system effectively helps users to engage in running meditation better. Our work enables users to practice mindfulness training during running without the help of any professional equipment in daily life.

References

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