Sonic Cradle - Immersive interaction design combining breathing and neurofeedback to foster focused attention meditation on breath

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INTRODUCTION & MOTIVATION

Mindfulness meditation practice is widely recognized for its psychological and physical well-being benefits (Kabat-Zinn, 1994). Mindfulness is a practice that brings "one's complete attention to the present experience on a moment to moment basis" (Kristeller & Hallett, 1999). Often for novice meditators, entering and maintaining a mindful state and focusing on the present moment is challenging. There are numerous focusing techniques that are practiced in mindfulness. Novice meditators are often guided in breathing exercises, encouraging them to breath deeply from their diaphragm (Debra E. Burdick, 2013). To assist meditators in breathing exercises, we are designing a system that encourages deep diaphragm (abdominal) breathing by providing real-time neuro- and biofeedback generated from EEG and respiration data. Our new design builds upon "Sonic Cradle" (Vidyarthi & Riecke, First International Conference on Mindfulness 2013, International Journal Of Human-Computer Studies 2014). Sonic Cradle is an exploratory HCI paradigm designed to foster meditative attentional patterns as a user progressively shapes a soundscape with their breath.

While the original design proved effective by helping users reach a state comparable to mindfulness meditation, participants reported that the soundscape occasionally distracted them from breathing mindfully. To address this, we are integrating EEG data from the Interaxon Muse headset to detect when users have achieved a state of focused attention, and gradually reduce the soundscape inconspicuously. Conversely, when EEG data reveals a state of distraction, the soundscape becomes more salient, increasing its ability to cue users back to their breath with curiosity as proved to be effective in Vidyarthi & Riecke (2013). This playful interaction is designed to invite users to focus on deep diaphragm breathing when the practitioner's thoughts begin to wonder and they are not focused on the present moment. Once they achieve focused attention, the interaction paradigm fades out, allowing users to meditate undisturbed.

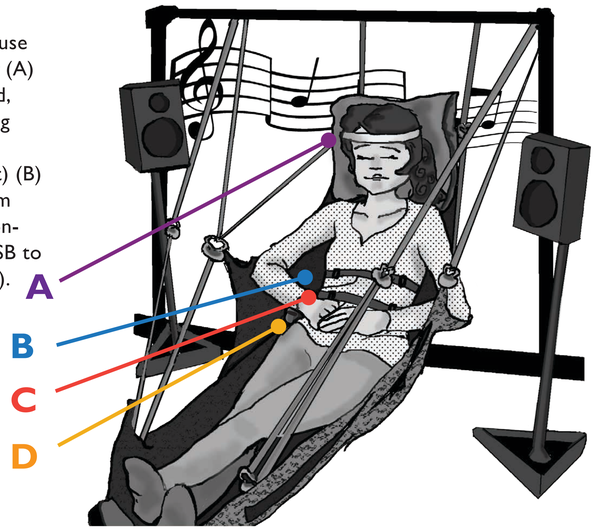


Figure 1: Interaxon Muse EEG Headset (A) worn on head, with breathing sensors on thorax (chest) (B) and diaphragm (belly) (C) connected via USB to computer (D).

METHOD

To test the feasibility of our design hypothesis and guide future development, we conducted a mixed-methods pilot study with an emphasis on quantitative data:

Participants: Eight participants (all SFU-SIAT students).

Procedure: A user (total of eight) entered a dark room and was comfortably seated in a hammock chair. The experimenter assisted participants in placement of respiration sensors (thoracic and abdominal) and Interaxon Muse EEG Headset. Once sensors were in place and connected, the experimenter instructed participants to explore the system in order to achieve a relaxed / meditative state. Participants were instructed that once they reach a meditative state, the sound will gradually fade. After a fifteen minute long session, the experimenter entered the room and assisted in removal of the sensors. Participants completed two questionnaires - State-Trait Anxiety Inventory (STAI-6) and Affect Grid (2-D 9x9) - before and after their session.

RESULTS

On average, the reported anxiety level after the Muse + Sonic Cradle session (M = 29.98, SE = 5.58), was significantly lower than before the session (M = 48.04, SE = 7.58), $t(7) = 4.416$, $p = .003$, $r = .858$ (indicating 73.6% of the variance). Arousal was also significantly lower after the session (M = 3.25, SE = .411) compared to before (M = 5.13, SE = .580), $t(7) = 3.910$, $p = .006$, $r = .828$. Pleasantness was significantly higher after the session (M = 7.00, SE = .655) compared to before (M = 4.63, SE = .653), $t(7) = -2.888$, $p = .023$, $r = .737$. The effect sizes for each indicate a substantive finding.

Figure 2: STAI-6 Measure (Values scored out of 100)

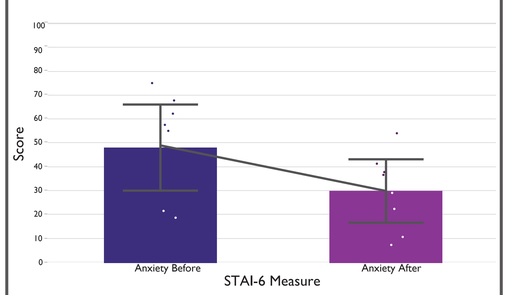
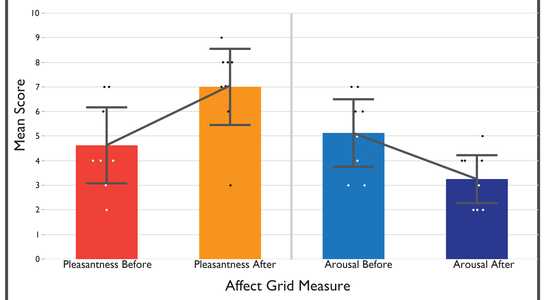


Figure 3: Affect Grid (Values scored out of 10)



Participant Feedback

Postive

"Great experience." ◆ "Fun and playful." ◆ "I actually feel better after." ◆"I feel relaxed." ◆"It was really comfortable." ◆"Everyone should do this!"

Negative

"Some sounds were disturbing and distorted, and not relaxing at all."◆"Sounds can be distracting." ◆"Maybe it's better you don't tell people that you've reached a meditative state when the sounds go away because I get anxious when I can't do that." ◆"Volume is too loud and it makes it hard to concentrate." ◆"The volume control with the Muse felt very discrete, either full blast or silence. I wish there was a more gradual change"

DISCUSSION & CONCLUSION

The presented results indicate the potential of the Sonic Cradle with Muse system supporting a transition from "regular" levels of pleasantness, arousal and anxiety to a measurable meditative and relaxed state. A previous study using Sonic Cradle without EEG did not find significant effects on the same self-report scales. Our results show incorporating EEG has potential.

Further studies are required to generalise the findings and compare our results with a control group. Informal post-session interviews revealed that some of the presented sounds were distracting, therefore a next step is to identify and replace those sounds. This feedback is consistent with Sas & Chopra's findings that certain pitches may lead to distraction and performance anxiety [Sas, 2015]. Another comment was related to participants being "too worried" when the sound was present, as they assumed that they were not performing well. While these issues did not prevent an overall benefit of the Sonic Cradle, it is important to address them in next system iteration. The revisions could include instructions to emphasize reflection on 'calmness', which is suggestive of mindfulness practices' focus of inner sensations opposed to a quantification of performance. We are also considering changes to the interaction paradigm, overall look-and-feel, and perceived demand characteristics to yield a more playful and less serious aesthetic of the session.

References

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