Effect of slow-paced resonance breathing exercises with Oxa on heart rate, respiratory sinus arrhythmia and mood.

A product evaluation project

NANOLEQ

Abstract Slow paced breathing exercises can have a beneficial effect on physiology and psychology. In this product development project, Oxa was used to perform biofeedback guided resonance breathing exercises compared to exercises with fixed pace at 6 breaths per minute as it's often done by meditation apps and wearables without biofeedback. The goal was to assess the effects of these exercises on heart rate and mood and to leverage the insights to improve Oxa. The study involved 12 volunteer participants. Generally, the individual's mood improved after all the exercises using Oxa but the results showed that heart rate oscillations during cardio-respiratory resonance were significantly higher in the biofeedback guided exercises.

Introduction Slow-paced breathing exercises have been recognized for their potential positive effects on both the mind and body. These exercises stimulate the cardiac baroreflex and the autonomic nervous system (ANS), in particular the parasympathetic nervous system (PNS). The resonance frequency (RF), also called "coherence" frequency at which respiratory sinus arrhythmia (RSA) is maximized, typically occurs around a breathing rate around 0.1 Hz (6 breaths per minute). However, exercising at the personal RF plays a crucial role in optimizing the positive effects of SPB. Oxa, a smart-garment, provides real-time biofeedback on the level of resonance, making it a suitable tool for optimizing resonance breathing exercises and its effect on body and mind.

Method For this project, 12 volunteer participants from Nanoleq's employee pool engaged in different types of slow paced breathing exercises using the Oxa platform. The exercises were all done with Oxa's audiovisual environment and included fixed rate 6 breaths per minute (bpm) without biofeedback as done by most meditation and breathing apps, fixed rate RF breathing at the previously identified personal resonance frequency but without biofeedback, and biofeedback RF breathing (bfRF, Table 1) where participants were guided to breathe first at their personal resonance frequency and then switch to freely adjust their breathing with the goal to maximize the resonance biofeedback. The participants were guided visually and audibly by the Oxa app during the exercises. The effects on physiology (cardiac variables) and mood were assessed through Oxa signal analysis and questionnaires.

Results The results showed that the participants successfully lowered their breathing rate during the exercises, as intended. It was noticed that participants switched to auditory guidance instead of visual instructions when possible. There was indication that during exercises, participants were breathing deeper compared to baseline. Average RSA increased in 21 out of 24 exercises, indicating the desired temporal change in heart rate amplitude oscillation during the exercises. Average heart rate decreased during the exercises, and there was a positive weak correlation between high heart rate variability (HRV) values calculated by RMSSD and RSA oscillations. The comparison between the fixed rate 6bpm exercise and the bfRF exercise showed that the bfRF exercise was done at lower breathing rates and larger RIP amplitudes (Figure 1). RSA was larger in the bfRF exercise compared to 6bpm (Figure 1). All exercises with Oxa induced an improvement in mood scores (Figure 2).

Conclusion This product evaluation project demonstrates the effectiveness of Oxa's biofeedback to guide participants in optimizing heart rate oscillations during resonance breathing. Additionally, it confirms a general immediate positive effect on the user's mood for all exercises done with Oxa. The results contribute to the ongoing development of Oxa, aiming to enhance the benefits of resonance breathing for users.

Figure 1: RIPperiod, HRperiod and RSA during sections of heart rate oscillations are higher in bfRF compared to 6bpm. Data are labelled as mean±stdev.
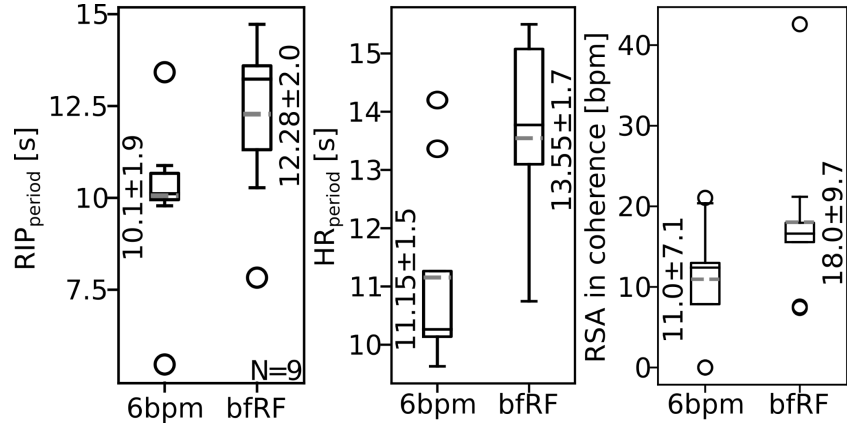

Figure 2: Significant improvement of mood after all breathing exercises with Oxa in an adapted POMS scale. Data are given as mean±stdev.
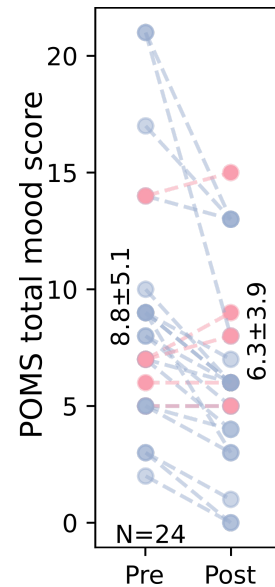

Table 1: Number of exercises conducted. The number behind the curly braces indicate how many participants conducted both exercises.

Exercise Type	N		
6 breaths per minute	11		
fixed RF	4	} 3	} 9
biofeedback RF	9		