NSERC-Create graduate award in Complex Dynamics

Cardiorespiratory optimized guided-breathing biofeedback for post-stress recovery in a group setting

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Introduction

- Regulating stress levels is important for practitioners in high-stress occupations also for dealing with stressful situations in an everyday context. Importantly, regulating mental stress can help reduce the risk for cardiac diseases (Steptoe & Kivimäki, 2012).
- Music therapy and resonance breathing is found effective in treating stress-related symptoms and promoting relaxation.
- Anxiety and respiratory rate reduction is seen in voluntary breathe-holding and guided breathing techniques (Meuret, Ritz, Wilhelm,Roth, & Rosenfield, 2018).
- Non-invasive stress management techniques involve biofeedback, primarily Heart rate variability (HRV) biofeedback (Moss, 2004).
- We investigated the effect of relaxing music and slow breathing on non-linear measures of HRV as potential intervention for stress reduction.

Hypothesis:
1. Does stressful movie effect HRV?
2. Can we see effect of Intervention in HRV?
3. Does the effect of intervention carries over ?

Method

- 16 healthy adults between the ages of 18 and 53 (Mean= 20, SD = 3.7) participated in the slow breathing experimental group and 16 adults between the ages of 18 and 53 (Mean= 20, SD = 7) participated in the music experimental group.
- This study was conducted from March 3rd, 2020 to March 14 th, 2020 in the LIVELab at McMaster University.

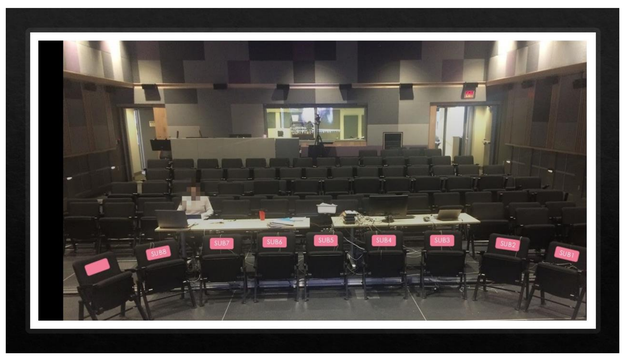

Fig: Experimental Setting:

- Experiment consisted of two groups (Music and Breathing) each with Baseline1, Stress, Intervention and Baseline 2 condition.
- PPG, Respiration, GSR and Algometer recordings were taken from Subjects.
- Participants also filled several stress related questionnaires.
- In stress condition subjects watched a movie, in breathing conditions subjects breathed to a stimuli and in relaxing music condition, subjects listened to the music.

Results

Sample Entropy: A measure of signal complexity
Detrended Fluctuation Analysis: A method for determining the statistical self-affinity of a signal.
Poincaré Plot: a graphical representation of the correlation between successive RR intervals

Sample entropy

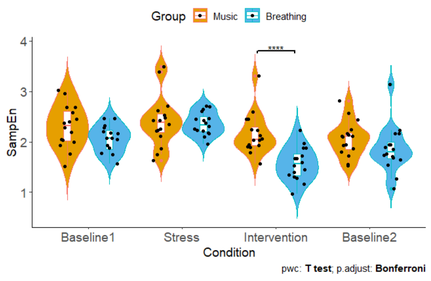

Fig 1

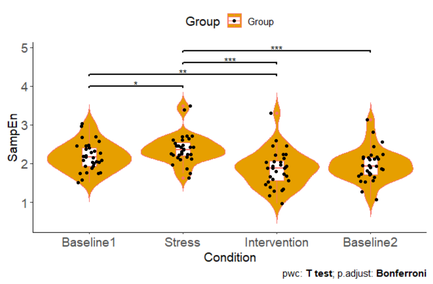

Fig 2

Detrended Fluctuation Analysis

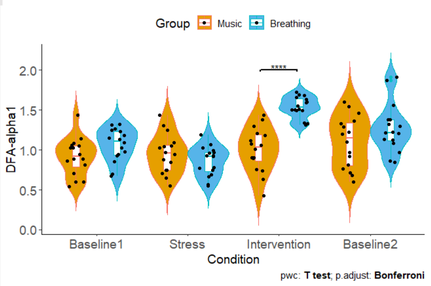

Fig 3

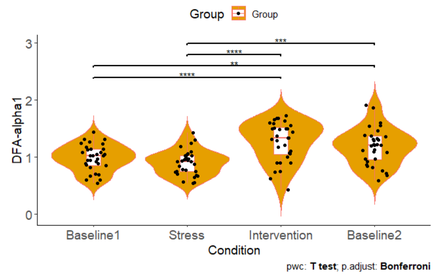

Fig 4

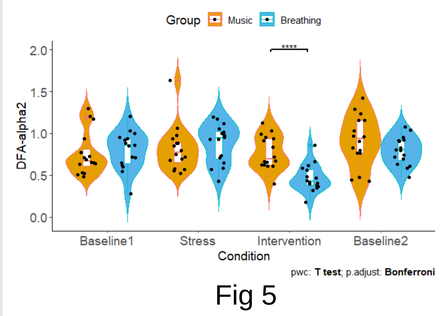

Fig 5

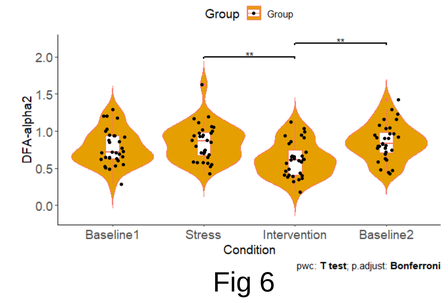

Fig 6

Poincaré Plot Analysis

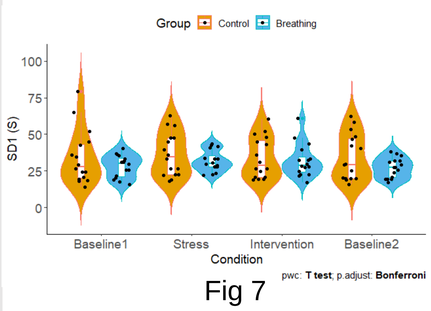

Fig 7

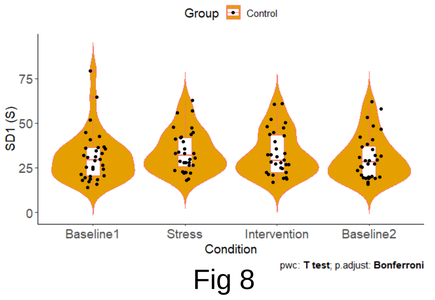

Fig 8

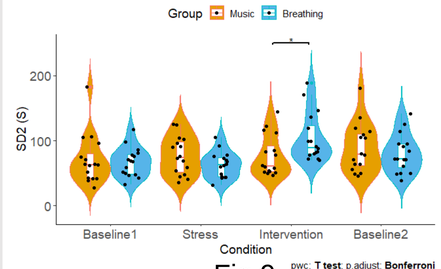

Fig 9

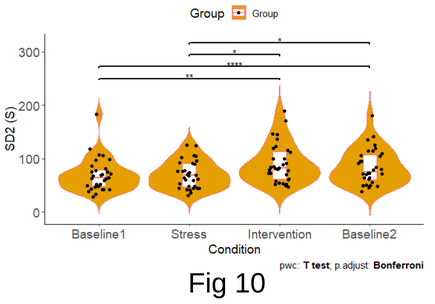

Fig 10

Discussion

- The nonlinear measures of HRV during the intervention phase differed significantly between groups in sample entropy, DFA-alpha1, DFA-alpha2 and in SD2.
- A decreased complex behavior of HRV through symbolic analysis, entropies and DFA during slow breathing has been reported previously (Porto et al. 2018, Weippert et al. (2015)).
- Fig 2,4,6,8,10 shows the comparison across experimental phase collapsed across groups.
- Fig 1,3,5,7,9 shows Pairwise Bonferroni corrected comparisons between treatment groups.
- Sample entropy differed significantly between groups during intervention p<.0001 also significant differences between baseline1 and stress condition is seen (p<.05).
- DFA-alpha1 was significantly higher in slow breathing compared to relaxing music condition p<.0001.
- DFA-alpha2 was significantly lower in slow breathing compared to music condition p<.00001.
- For Poincare analysis, SD2(s) was significantly higher in slow breathing condition p<.05.

- Conclusion: Nonlinear matrices of HRV are significantly effected by slow breathing as compared to relaxing music. The complexity and unpredictability of the heart rhythm reduces during slow breathing. Results are in line with previous findings (Porto et al. 2018; Weippert et al. 2015).

References

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Acknowledgments

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