Predicting Positive Distance Running Experiences

Alex Netzley (Honors Capstone)

Faculty Advisor: Prof. Noel Perkins
Graduate Student Advisor: Jamie Ferris

ENGINEERING HONORS PROGRAM
UNIVERSITY OF MICHIGAN

Introduction

- < ¼ adults reach fitness guidelines[1]
- Running is a simple and accessible form of exercise
- Better Feeling Runs = More Running[2]

Can we make running more enjoyable?

- ECG (heart rate) data could indicate running enjoyment
- Heart Rate Variability (a metric calculated from ECG) shows promise due to its relationships to general health (stress[3], sleep[4], and diet[5]), **exercise[6]** and **emotion[7]**

Methods

1. Experimental Protocol

- Pilot data from three trial runs on the same course
- ~50 min of steady-state overground running
- Subject Details
  - Female
  - Mid-20's
  - Experienced Distance Runner and Racer

2. Instrumentation

- Polar H10 Chest Strap Heart Rate Monitor sampling at 130 Hz
- Recorded enjoyment (via Feeling Scale ratings) throughout run

Fig. 1: Polar H10[10]

3. Data Pre-Processing

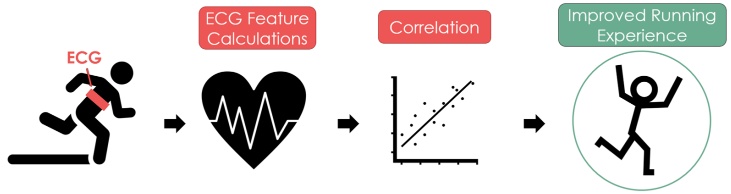
- Raw ECG data imported into Kubios HRV software[8]
- Upsampled data through 4Hz cubic spline interpolation[9]
- Performed automatic heartbeat correction algorithm identifying erroneous beats
- Calculated 8 different time-varying HRV features using a sliding window of varying lengths

4. Data Analysis

- Imported HRV features and Feeling Score time-series into MATLAB
- Overlayed the Feeling Score with each HRV feature to determine optimal data representations to assess correlation
- Performed correlation tests over all features over a range of window interval durations

Project Goal

Assess the promise of utilizing ECG (heart rate) data in a wearable biofeedback system to improve running experiences



Exemplar Results: Heart Rate Variability

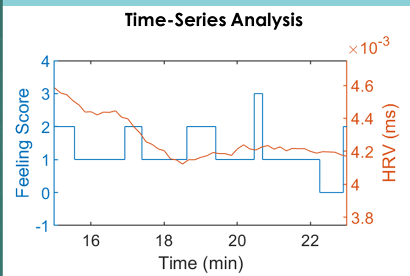


Figure 2: An exemplar 8-minute section of Feeling Score and HRV overlayed.

- No obvious trends in time-series data

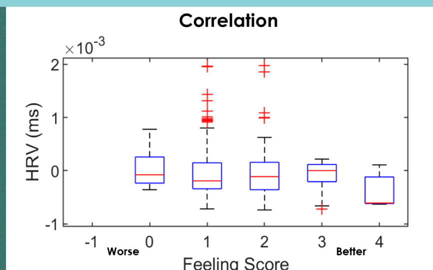


Figure 3: HRV vs Feeling Score box plots.

- No obvious trends across Feeling Score

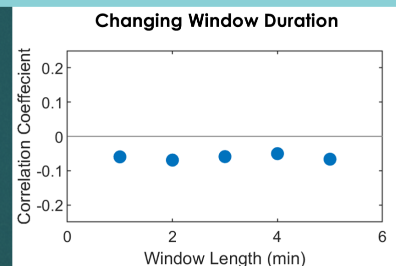


Figure 4: Correlation Coefficient vs Window Length.

- Consistently low correlation coefficient across all window durations

Conclusions

No obvious correlation or relationships existed between any of our calculated ECG features and Feeling Score. If ECG data is to be implemented in a wearable biofeedback system, **more complex analysis** will likely be needed to produce useful results.

Limitations

- Only used data from a single subject
- Reliability of subjective Feeling Score
- ECG signal/HRV feature quality during exercise

Next Steps

- Collect more data (more subjects and more runs with each)
- Integrate data into more complex predictive model (machine learning)

References

[1] Whitfield 2019 (MMWR)
[2] Rhodes 2015 (Ann. Behav. Med.)
[3] Kim 2018 (Psychiatry Investig.)
[4] Sajjadieh 2020 (Tanaffos)
[5] Young 2018 (Behav. Pharmacol.)
[6] Silva 2017 (J. Strength. Cond. Res.)
[7] Chapleau 2011 (Heart Fail. Rev.)
[8] Kubios HRV Premium (v. 3.50, Kuopio, Finland)
[9] Ellis 2015 (Physiol.)
[10] Polar H10 (Polar Electro, Kempele, Finland)