Utilizing Heart Rate Variability as an Indicator of Post-Traumatic Stress Disorder (PTSD)

Rodriguez-Paras, C.1, Sasangohar, F.1,2, 6, Benzer, J.K.4,5, Kum, H.-C.1,2,4

1 Department of Industrial and Systems Engineering, Texas A&M University
2 VA VISN17 Center of Excellence for Research on Returning War Veterans
3 Center for Remote Health Technologies and Systems, Texas A&M University
4 Department of Health Policy & Management, Texas A&M University
5 Department of Environmental and Occupational Health, Texas A&M University
6 VA Boston Healthcare System

1. Background

Post-traumatic stress disorder (PTSD) is a mental health disorder that is estimated to impact up to 23 percent of all Veterans returning from the recent wars in Iraq and Afghanistan. Critical Need: to investigate and develop alternative objective tools to detect and treat PTSD.

PTSD is detected through subjective measures. Particularly, the PTSD Checklist 5 (PCL-5).

- 20 self-reported measures
- Emotional numbness can affect subjective results.

2. Research Aims

Aim 1: Explain the workings of heart rate variability (HRV) as indicator of sympathetic arousal
Aim 2: Summarize the relationship between sympathetic arousal and heart rate variability (HRV)
Aim 3: Motivate the use of real-time, non-intrusive physiological sensors as possible detectors of post-traumatic stress disorder (PTSD)

3. Methods & Results

3.1 Heart Rate Variability (HRV)

HRV
- Natural beat to beat variations in subsequent heart beats.
- Denoted by the R-R interval from the QRS complex in ECG
- Modulated by autonomic nervous system (ANS), which is composed of the sympathetic and parasympathetic systems.

Parasympathetic “Rest and digest” response
- Internal organs and their functions
- Decrease activity results in cardiac acceleration and decreased HRV

Sympathetic “Fight or flight” response
- Stress, heart disease, or exercise
- Activates due to external changes
- Increased activity results in cardiac acceleration and decreased HRV

3.2 Heart Rate Variability Measures

HRV Measures
- Different time windows can be used.
- Short time window is usually 5 minutes
- Long time windows analyse data over 24 hours.
- Analyses the R-R interval from the QRS complex in ECG
- Mainly categorized as time measures or frequency measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>Definition</th>
<th>Time Domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDNN</td>
<td>Standard deviation of the R-R interval</td>
<td>Long</td>
</tr>
<tr>
<td>RMSSD</td>
<td>Root mean square deviation of successive R-R intervals</td>
<td>Short</td>
</tr>
<tr>
<td>NN50</td>
<td>Number of N-N intervals greater than 50 milliseconds</td>
<td></td>
</tr>
<tr>
<td>pNN50</td>
<td>Percentage of N-N intervals greater than 50 milliseconds</td>
<td>Short</td>
</tr>
<tr>
<td>LF</td>
<td>Low frequency (0.04 – 0.15 Hz)</td>
<td></td>
</tr>
<tr>
<td>HF</td>
<td>High frequency (0.15 – 0.4 Hz)</td>
<td></td>
</tr>
<tr>
<td>Ratio (LF/HF)</td>
<td>Low frequency over high frequency</td>
<td></td>
</tr>
</tbody>
</table>

3.3 Heart Rate Variability and PTSD

PTSD could be detected in an objective manner through physiological measures
- Studies show that PTSD patients have decreased HRV, indicating sympathetic arousal (hyperarousal).
-Analysis of veterans before and after their tour analysing HRV found it to be decreased after.
- HRV, combined with subjective measures, could indicate when someone suffers from PTSD.

Limitations
- It is still not clear if the decreased HRV in PTSD patients is due to increased sympathetic arousal.
- Even though it is widely understood that PTSD patients have lower HRV, more studies are needed to fully understand the connection.
- HRV needs to be calculated, making it difficult to obtain data in real time
- Other physiological measures need to be explored to detect PTSD.

4. Implications

HRV could be used as an objective measure of PTSD.

- Wearable devices, such as smartwatches, show promise for data collection.
- Patients and clinicians could use the data to monitor their symptoms.
- HRV could be used to provide biofeedback

5. Current Work

HRV as an indicator of PTSD.

-Investigating PTSD patients and healthy populations to analyse HRV as an objective measure of PTSD.
- Developing a smartwatch app that can help determine when a patient experiences PTSD triggers
- Performing iterative testing to improved the detection algorithm

6. Future Work

Test the smartwatch app with PTSD patients

- Once the smartwatch app is developed and tested in the lab, it will be tested with PTSD patients

For more information about this work, contact Dr. Farzan Sasangohar: sasangohar@tamu.edu - (979) 458-2337