

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



APPLIED COGNITIVE ERGONOMICS LAB

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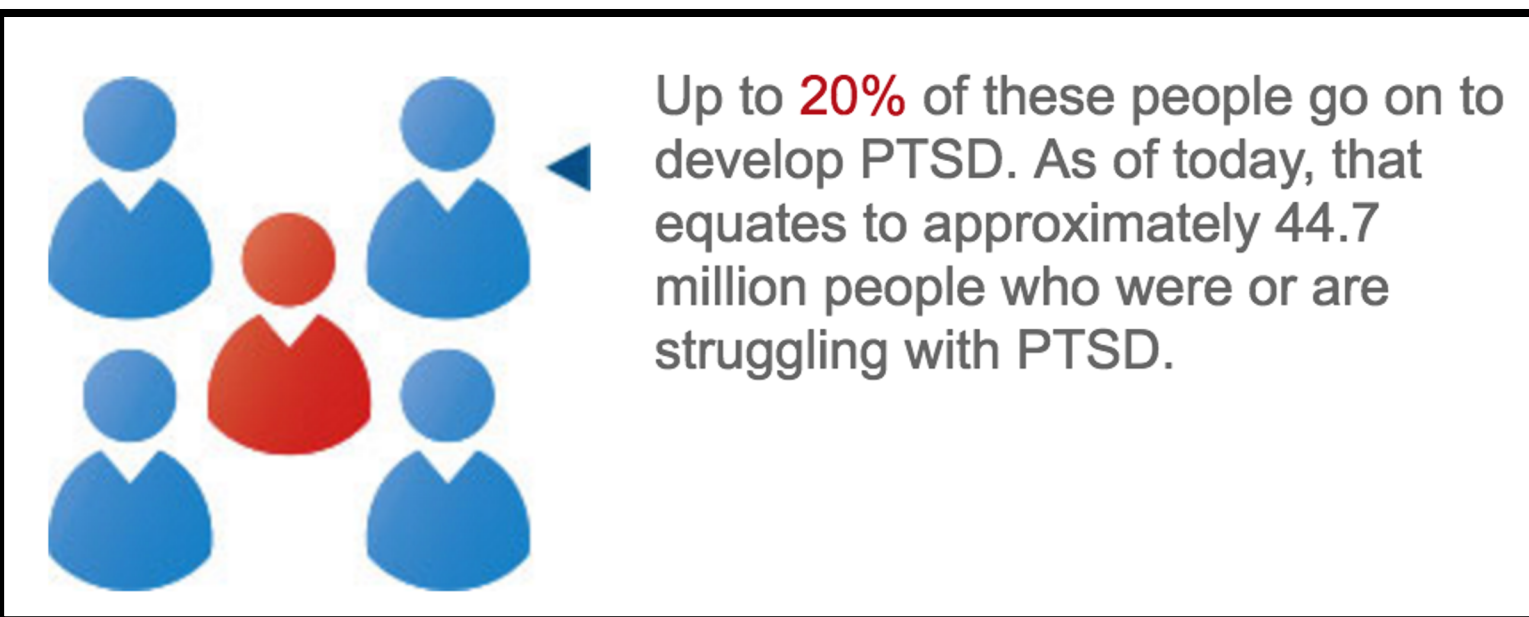
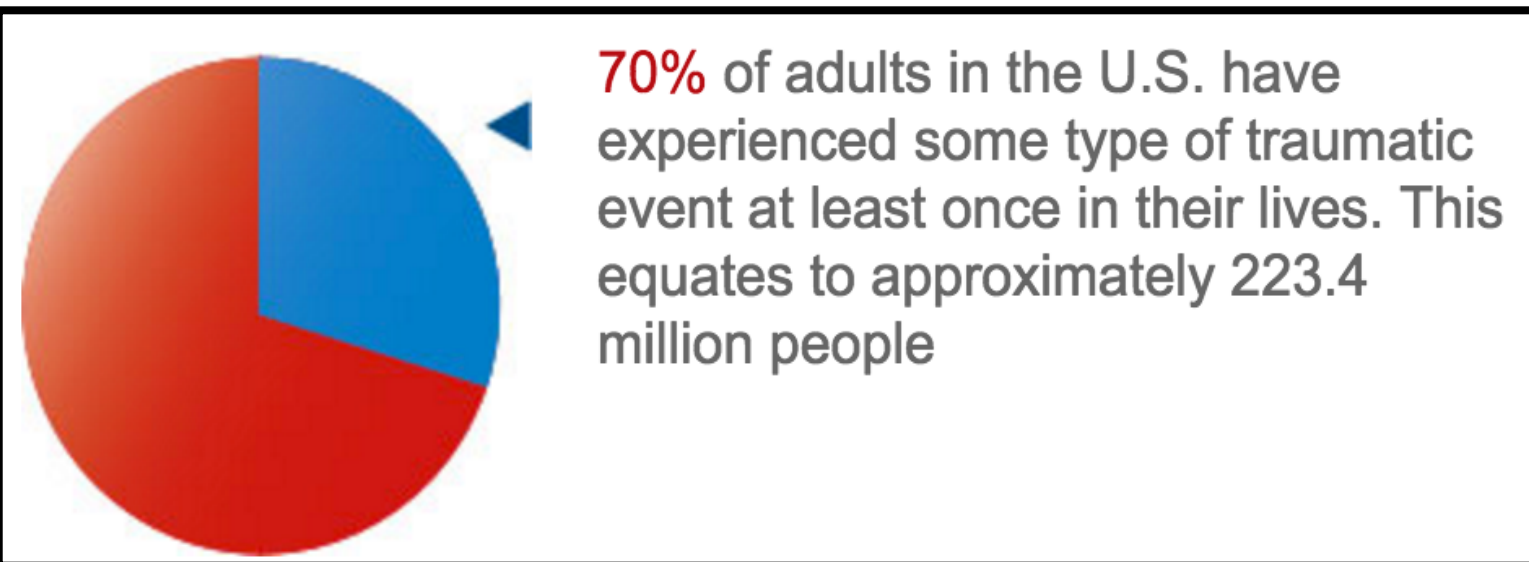
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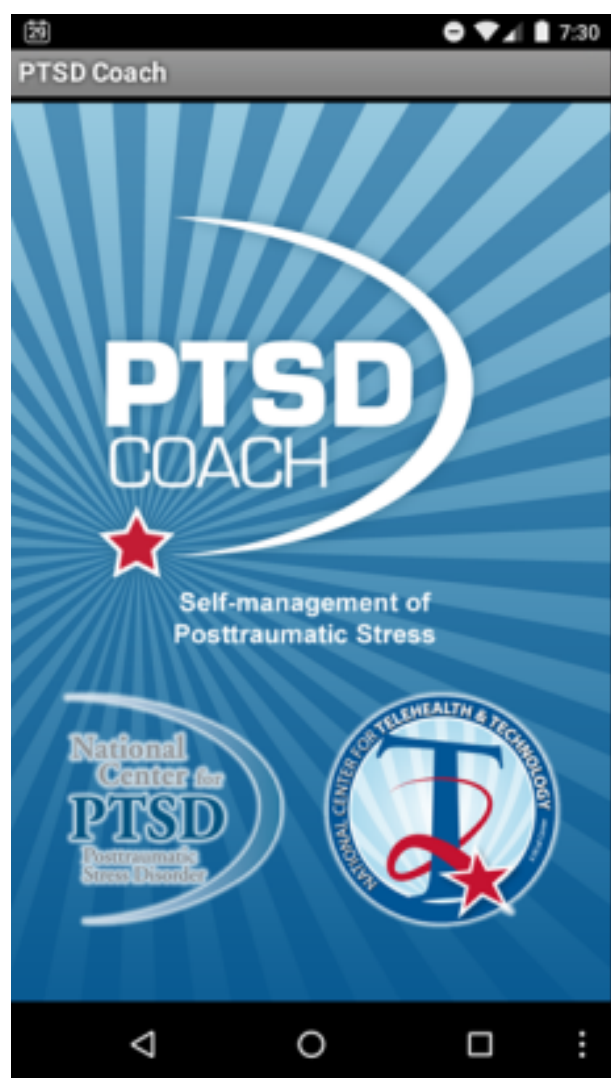
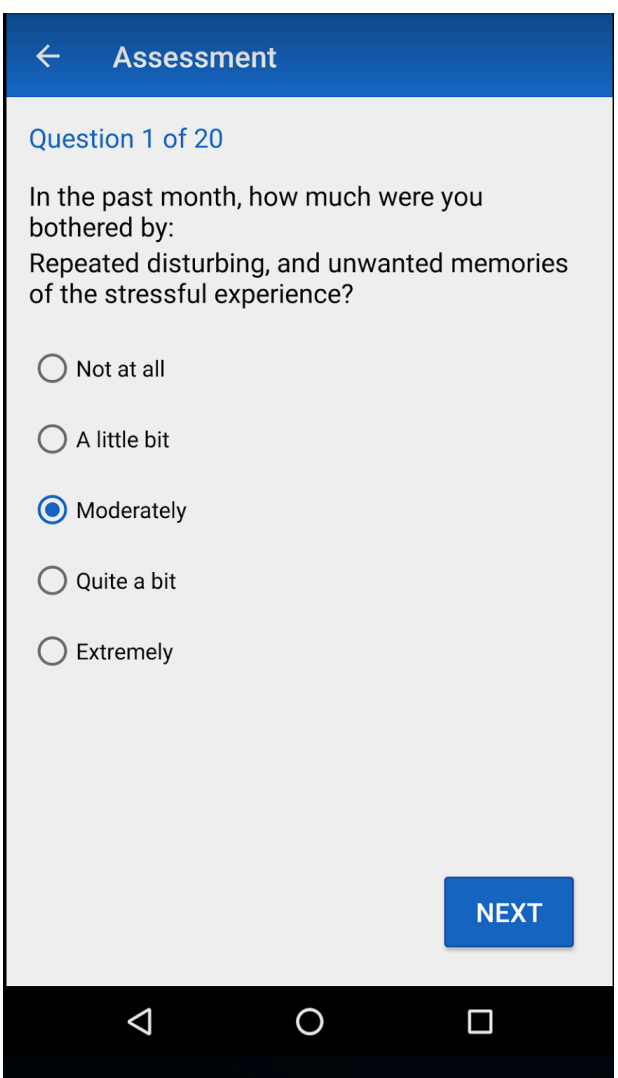
## 1. Background

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.



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

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



**Critical Need:** to investigate and develop alternative objective tools to detect and treat PTSD.

## 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)

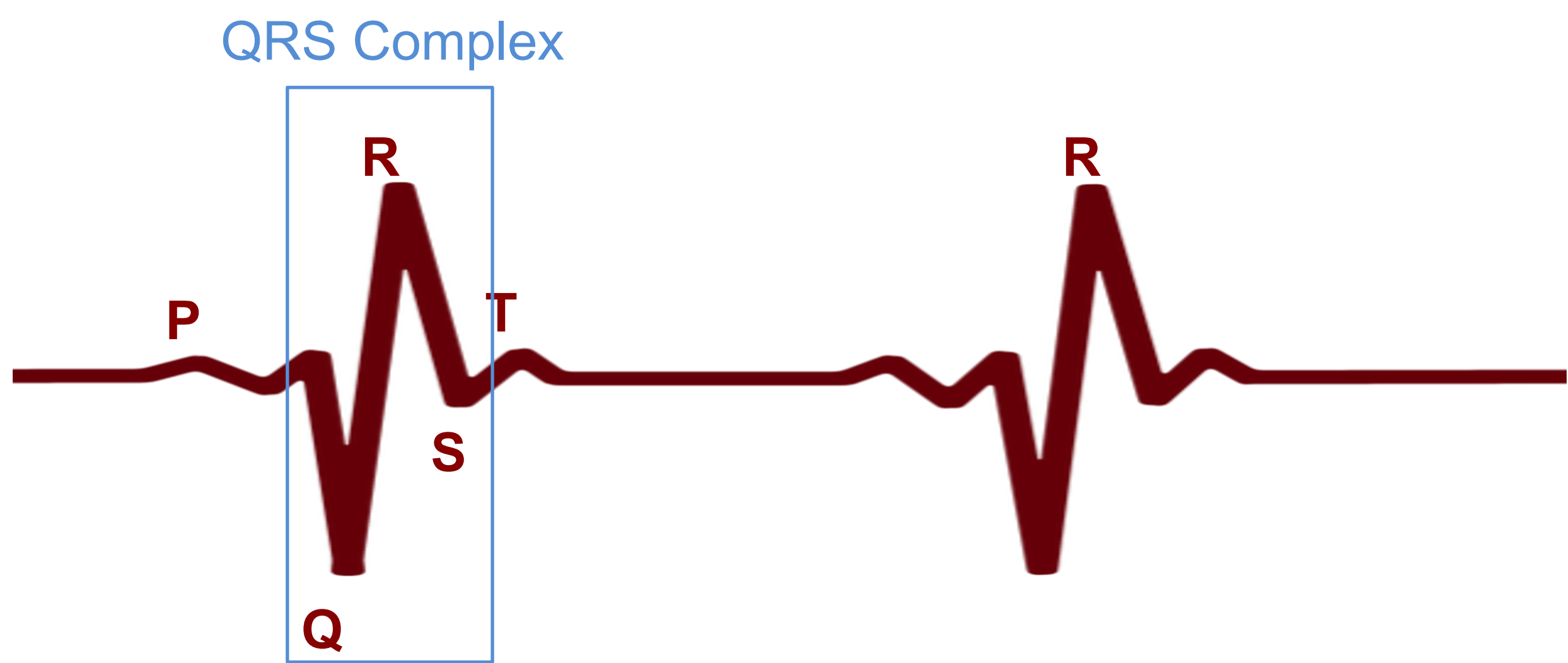
**Aim 3:** Motivate the use of real-time, non-intrusive physiological sensors as possible detectors of post-traumatic stress disorder (PTSD)

## 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
- Activates due to internal changes
- 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

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

### 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

