PTSD and a new way to fight it

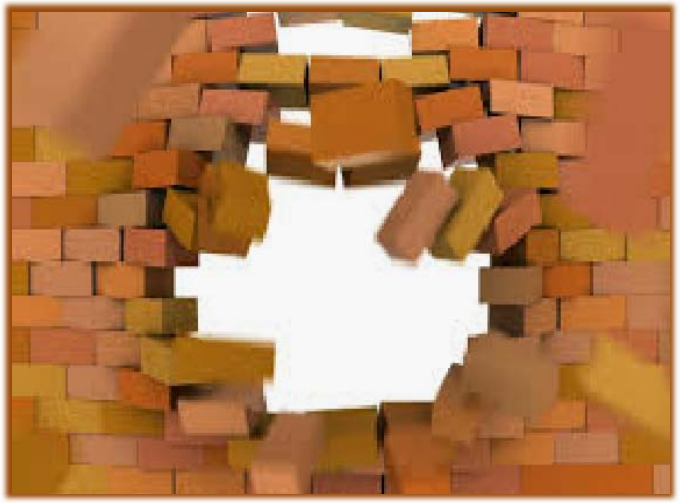
By

Apurva Lanman
Principal Investigator
Ph.D. Industrial Eng., Student
Apurva.Lanman@Knights.ucf.edu

Dr. Gene Lee
Ph.D. Advisor
Associate Professor
GLee@ucf.edu

Dr. Robert Kennedy
Subject Matter Expert
Adjunct Professor
Robert.Kennedy2@ucf.edu

PTSD Research



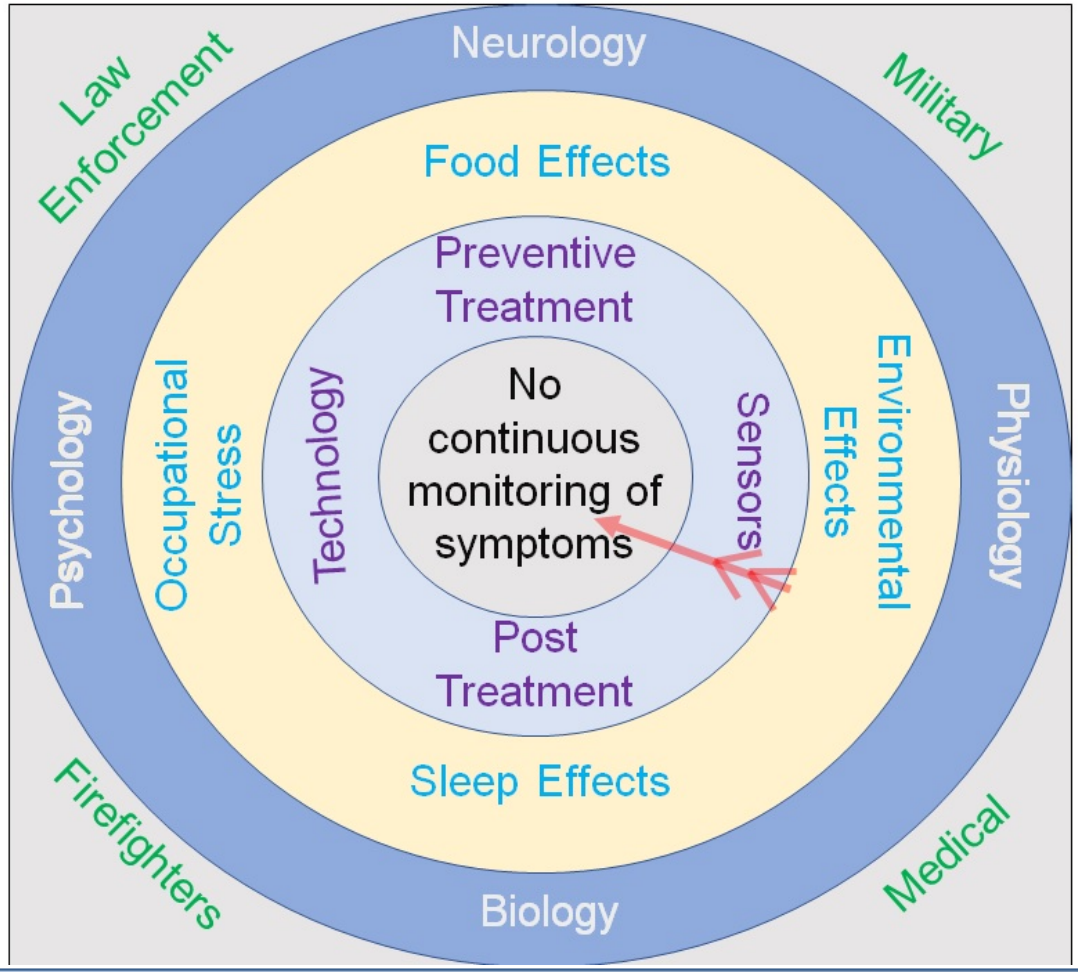
- PTSD is severe anxiety caused due to the experience of or exposure to a traumatic situation
- People with PTSD may have depression or another type of anxiety before developing PTSD

PTSD – Undiagnosed

- Mental health stigma prevents people from getting anxiety diagnosis
- 20 soldiers commit suicide because of PTSD

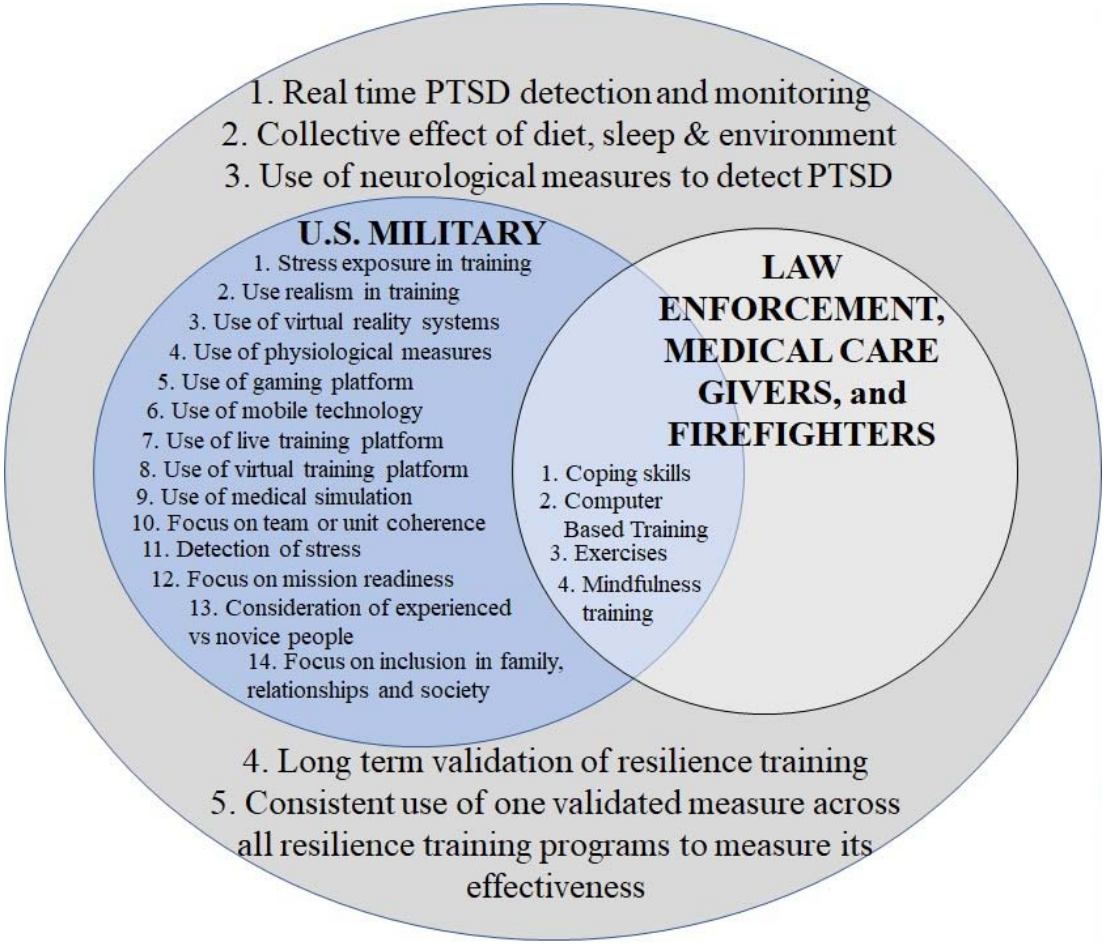
Primary Gap In Research

- 200 documents/ articles reviewed
- Primary gap - No continuous detection & monitoring of PTSD symptoms



Gaps In Research

- Five gaps across all domains
- U.S. Military has advance, inclusive, and effective PTSD resilience training compared to other domains



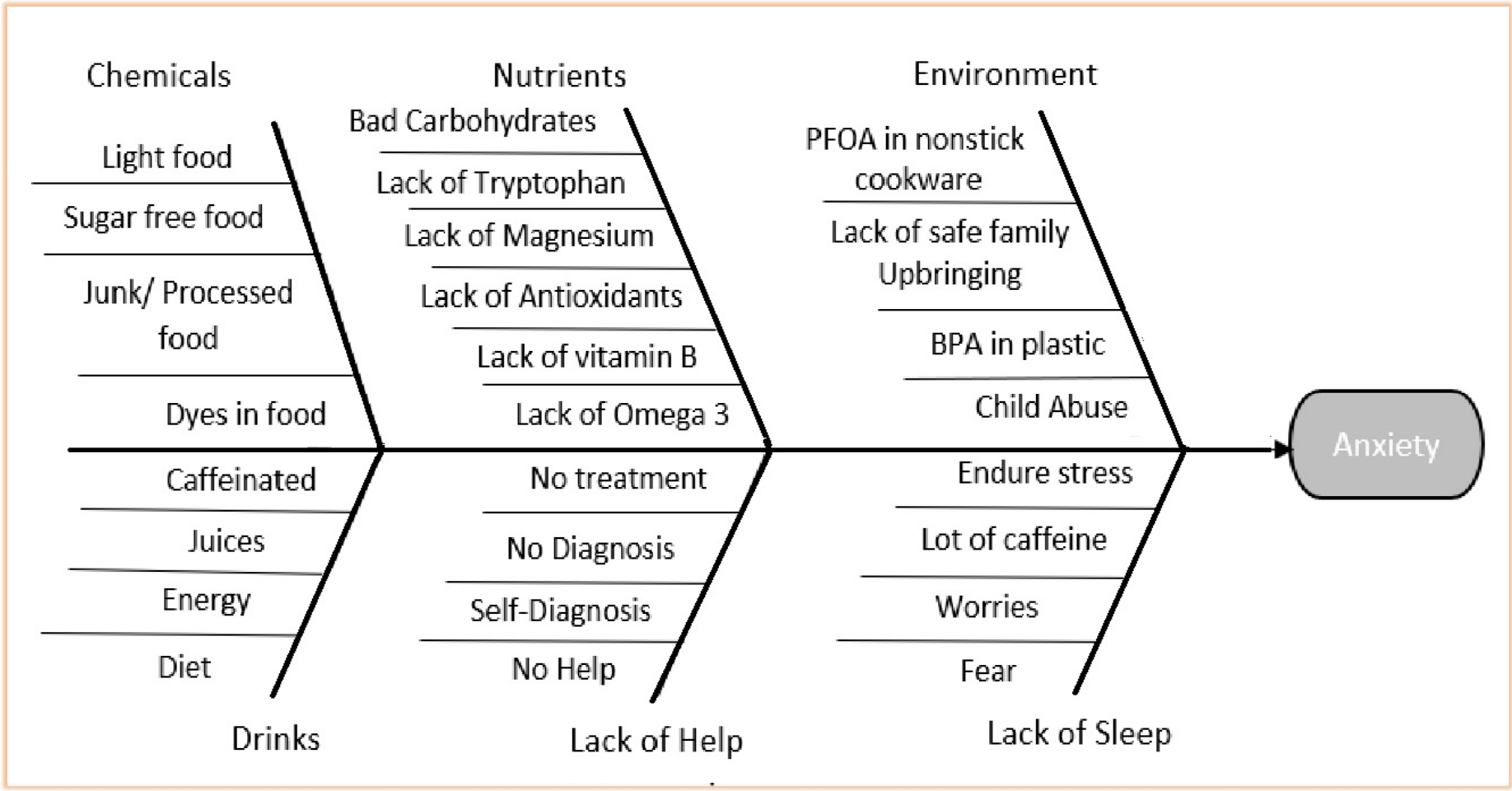
Three Studies

Study 1	Study 2	Study 3
Validate people's willingness to fight anxiety	Collect data to detect anxiety	User testing - Detect, Alert and Distract anxiety to stop its progression
Realistic effects of diet, sleep, and environment collectively		

Study 1 - Background

- No study conducted on the collective effect of diet, sleep and environment on people who have PTSD or any other anxiety
- Test people's willingness to empower themselves to combat their anxiety
- Validate the need for an engineering solution which may detect anxiety and help monitor it

Study 1 – Root Cause Analysis



Study 1 - Design and Participants

Design:

Survey with 53 questions on symptoms, diet, sleep, environment, quality of life, & empowerment

Participants:

General Anxiety Disorder (GAD) - 19

Specific Phobia (SP) - 6

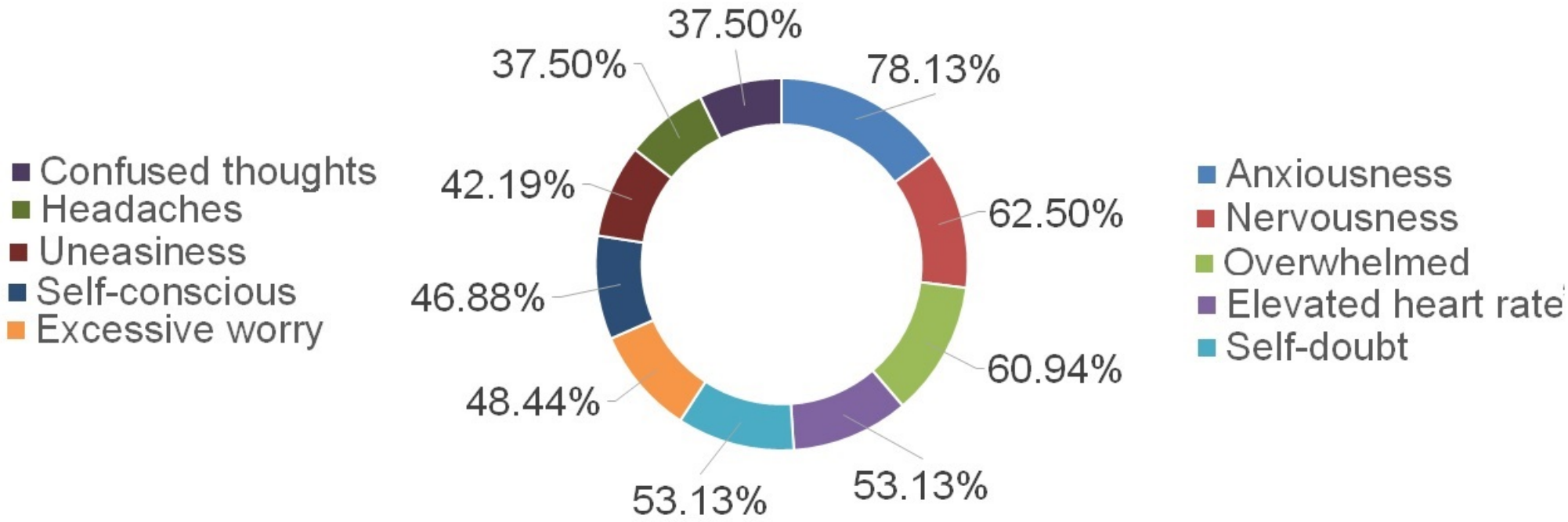
Social Anxiety Disorder (SAD) - 15

Panic Disorder (PD) - 16

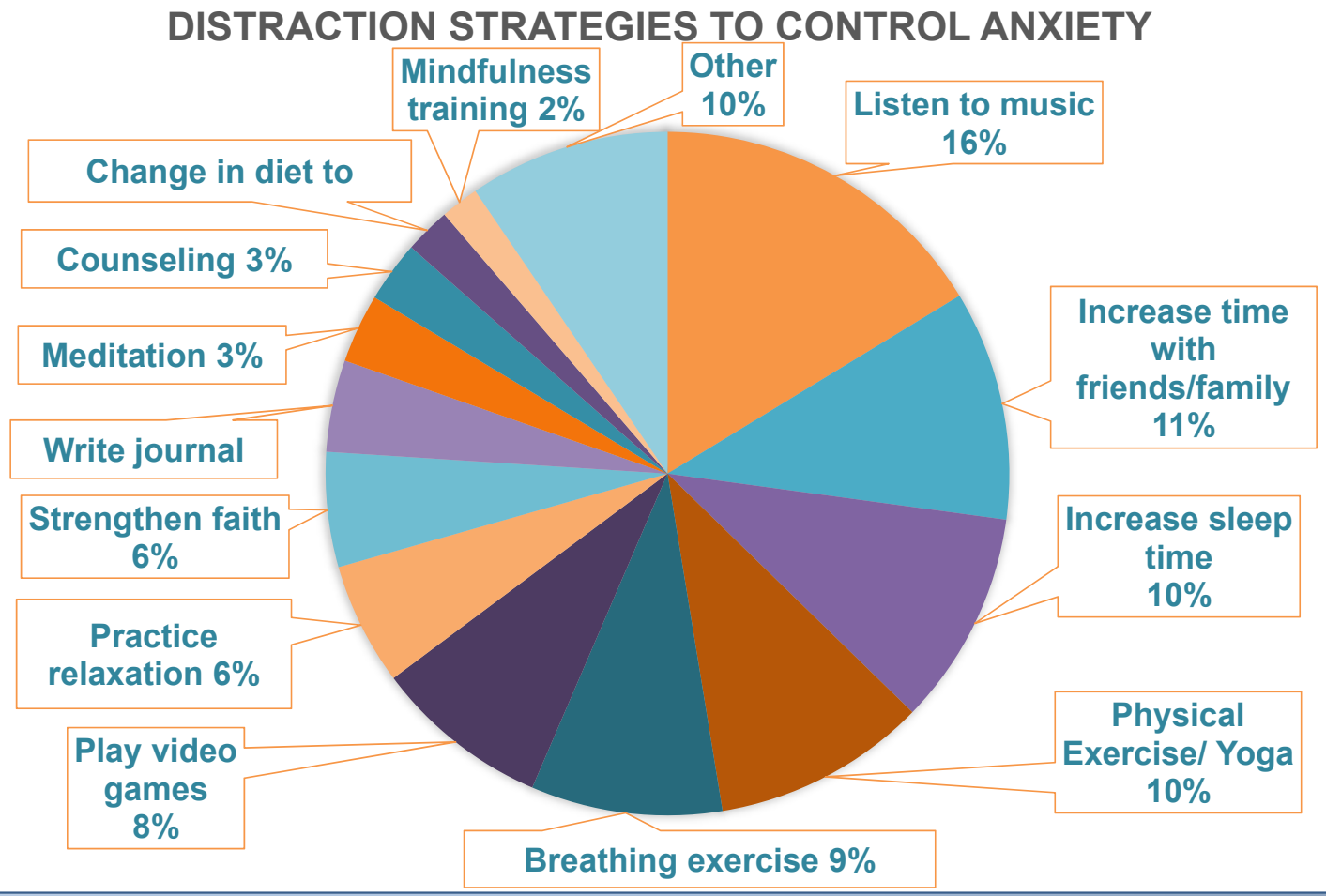
Post-Traumatic Stress Disorder (PTSD) - 5

Obsessive Compulsive Disorder (OCD) - 3

Study 1 – Top Ten Anxiety Symptoms Reported



Study 1 – Results on Distraction Strategies



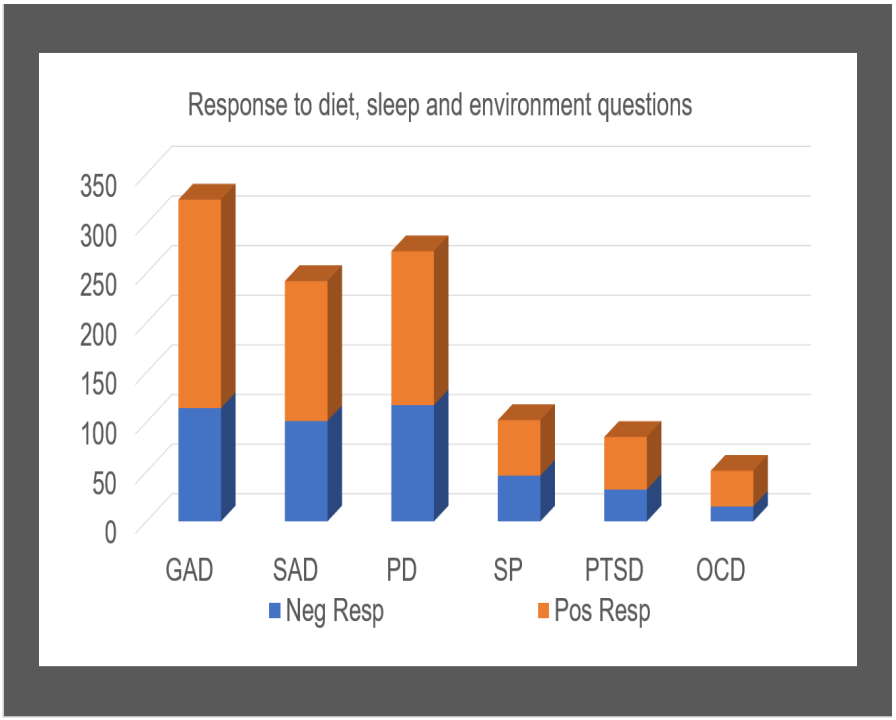
Study 1 - Results On Quality Of Life

97%	89%	81%	78%	72%
				
Develop negative attitude	Symptoms affect their life	Try to change negative thoughts & attitude	Have negative thoughts & emotions	Living with fear or skepticism

Study 1 – Results on Pos and Neg Responses

- Positive responses are significantly higher than the negative responses (t statistics = -2.948, df = 197.3, p = 0.004)

Positive Responses	Negative Responses
Healthy diet	Unhealthy diet
≥ 8 hours of sleep	< 8 hours of sleep
Less consumption or interaction with harmful chemicals	More consumption or interaction with harmful chemicals



Study 1 - Result

Healthy diet + good sleep + less harmful substances

no anxiety

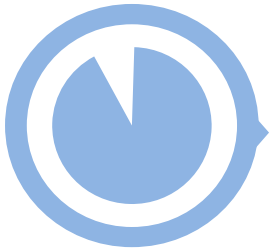
Chemicals In Diet and Environment

- Chemicals used in cereals, processed food, red dyes, sugar-free foods, nonstick cookware, plastic products, sales receipts, fertilizers, pesticides, insecticides, cleaning products, fabric making, and several other products lower mental health

FDA Chemical Allowance Limits In Products

- FDA's approach to setting harmful chemical allowance limits on the individual products is not good enough
- FDA needs to analyze the total impact of the chemicals in the products based on the daily consumption or interaction of several products containing harmful chemicals
- The combined effect of the chemicals in the diet and environment is causing a major negative impact on mental health, and it reduces people's ability to be mentally resilient

Study 1 - Results On Empowerment



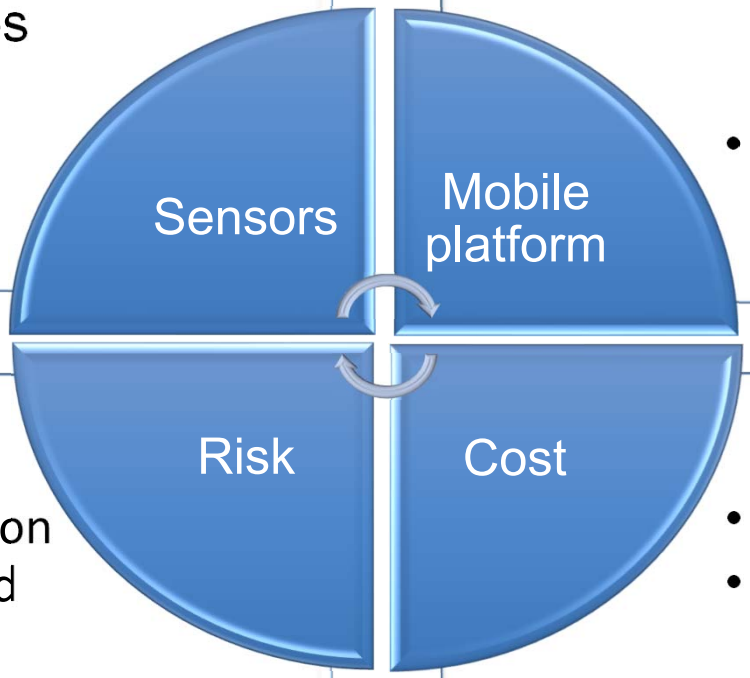
91% does not take any medication or supplements

92% show a willingness to empower themselves to fight anxiety

Need an engineering solution that detects anxiety and allows people to monitor and control it as it occurs.

Prototype Engineering Solution - Planning

- Measurements
  - HRV, brainwaves
- Wearables
  - Polar H10
  - Muse band



- Android system compatible with wearables
- PI Android app testing experience

- BlueTooth Integration – Hired Experienced Android Developer

- Hardware
- Software Application

Prototype Engineering Solution - Development

- Agile Development
  - Major sprints
    - Creation of SW app framework
    - Integrating Android tablet with Polar H10 and receiving R-R interval to calculate HRV
    - Integrating Android tablet with Muse band and receiving brain waves scores
    - Capturing and storing baseline values
    - Capturing/analyzing/storing experiment values
    - Detecting anxiety and generating alert

Prototype Engineering Solution – Measurements

HRV Values

Table 2 | Meta-analysis results of HRV in specific anxiety disorders.

Meta-analysis performed	No. of data sets	Number of anxious participants	Number of control participants	Comparison of anxious and control participants		
				Effect size (95% CI)	SE of summary effect size	*p* value
All disorders						
Time domain HRV[a]	20	1615	1402	−0.70 (−1.45 to −0.05)	0.38	0.07
HF HRV	34	915	1659	−0.29 (−0.41 to −0.17)	0.06	<0.001
LF HRV	22	715	1115	−0.08 (−0.31 to 0.15)	0.09	0.49
Panic disorder						
Time domain HRV	8	264	243	−0.41 (−0.68 to −0.15)	0.13	0.002
HF HRV	16	437	520	−0.22 (−0.42 to −0.02)	0.10	0.030
LF HRV	12	360	426	−0.11 (−0.47 to 0.25)	0.18	0.544
Post-traumatic stress disorder						
Time domain HRV	4	86	76	−0.69 (−1.00 to −0.38)	0.16	<0.001
HF HRV	7	192	525	−0.29 (−0.58 to −0.001)	0.15	0.049
LF HRV	6	183	516	−0.04 (−0.51 to 0.42)	0.24	0.854
Generalized anxiety disorder						
Time domain HRV	3	65	66	−0.55 (−0.89 to −0.21)	0.18	0.002
HF HRV	3	68	90	−0.56 (−0.87 to −0.25)	0.16	<0.001
LF	1	16	19	0.50 (−0.16 to 1.16)	0.34	0.140
Obsessive–compulsive disorder						
HF HRV	2	40	63	−0.28 (−0.84 to 0.28)	0.29	0.328
LF HRV	1	26	24	−0.08 (−0.63 to 0.47)	0.28	0.773
Social anxiety disorder						
Time domain HRV	1	53	53	−0.40 (−0.79 to −0.02)	0.20	0.038
HF HRV	3	90	113	−0.47 (−0.74 to −0.20)	0.14	0.001
LF HRV	1	53	53	−0.25 (−0.63 to 0.13)	0.19	0.205
Specific phobia						
Time domain HRV	1	61	58	−0.38 (−0.74 to −0.02)	0.18	0.037
HF HRV	1	61	58	−0.05 (−0.41 to 0.31)	0.18	0.784
LF HRV	1	61	58	−0.05 (−0.41 to 0.31)	0.18	0.782
Mixed anxiety						
Time domain HRV[b]	3	1086	906	−1.52 (−4.13 to 1.08)	1.33	0.251

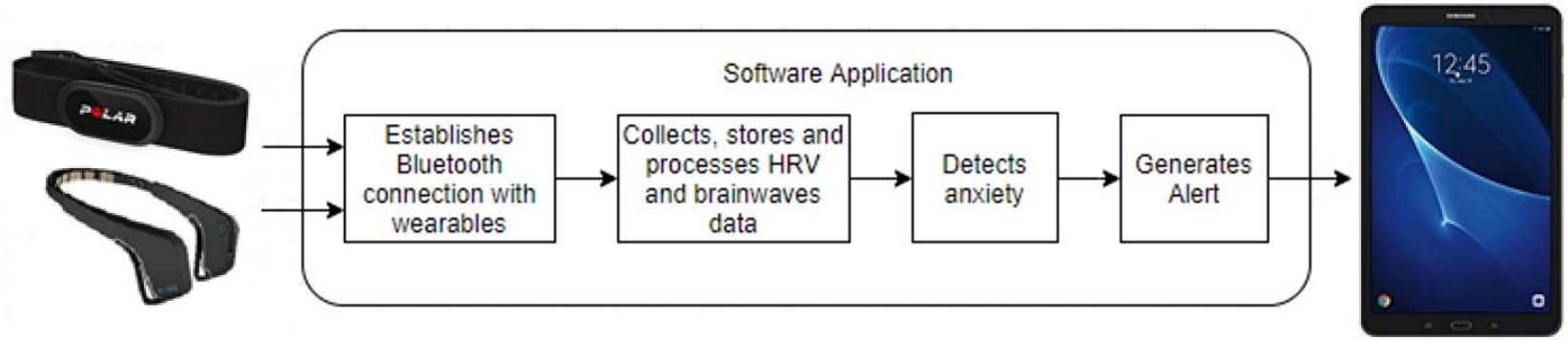
Brainwave Values

- Alpha waves represent meditative state
- Beta waves represent active state

During anxiety:

- Alpha waves decreases & Beta waves increases

Prototype Engineering Solution - Architecture



Prototype Engineering Solution – System Reqs

- Integration of Polar – H10
  - Establish BlueTooth Connection
  - Receive real-time R-R interval data
  - Derive HRV values from R-R interval
  - Continuously display HRV values in DADA App
- Integration of Muse band SDK
  - Establish BlueTooth Connection
  - Receive EEG data for alpha and beta brainwaves
  - Continuously display brainwave values in DADA App

Prototype Engineering Solution – System Reqs

- Display all measurements simultaneously
- Store all measurements separately
- Capture baseline and store baseline values
- During the experiment, compare HRV and brainwaves values to its baseline values in real-time and store all measurements
- Generate an alert if symptoms are detected and store the instances data in the App

Prototype Engineering Solution – SW Application

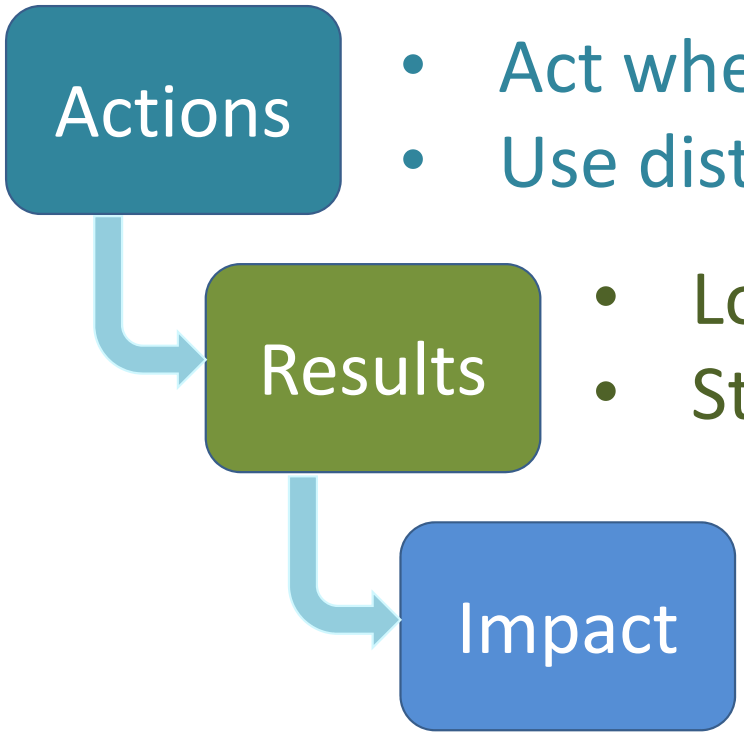
Study 2 – Anxiety detection algorithm

- Objective – Collect data to generate anxiety detection algorithm
- Data
  - Brainwaves alpha scores, beta scores
  - HRV (derived)
- Participants
  - People with speech anxiety
- Experiment
  - Baseline data
  - Introduce stressor to cause anxiety and collect data
- Methodology
  - Capture Baseline data
  - Start Experiment
  - Introduce stressor to cause anxiety

Study 3 – Detect, Alert & Distract (DADA) Model

- Objective
  - Detect anxiety and distract it to lower its effects and stop its progression. Improve the quality of life.
- Participants
  - People with speech anxiety
- User testing DADA Model
  - Detect anxiety
  - Alert user
  - Provide distraction strategies to stop anxiety

Study 3 – DADA Benefit



- Act when alerted
- Use distraction strategy for 5-10 minutes

- Lower effects of anxiety
- Stop the progression of anxiety

- Improved task performance
- Improved quality of life
- Increased mission readiness

Conclusion

- Managing diet, sleep and environment alone cannot help solve the anxiety problem
- An engineering solution that detects anxiety is an absolute need
- Monitoring and controlling the anxiety as it flares up is like putting a bandage on a cut as soon as it occurs and prevent its progression

Discussion

- Integrating two wearables:
  - Challenge integrating two BlueTooth devices
  - Challenge receiving data from two wearables simultaneously
  - Lack of proper support from the wearable manufacturers during the development
- Proper placement of the wearables is required to reduce noise in data or loss of data

Discussion

- Limited participant's motion to reduce noise in the data
- Need to create anxiety detection algorithm to detect different types of anxiety

Questions