



Next Generation Healthcare Technology: Quantifying the Qualitative to Inform Care

Andrea Webb, Ph.D.

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The Charles Stark Draper Laboratory, Inc.
555 Technology Square, Cambridge Mass. 02139-3563
CAGE Code: 51993

Disclosure

1. Neither I nor my spouse/partner has a relevant financial relationship with a commercial interest to disclose.



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*The convergence of
biotechnology, engineered
microsystems, and AI will
transform all facets of life.*

**Draper will help the nation navigate these
opportunities and challenges.**

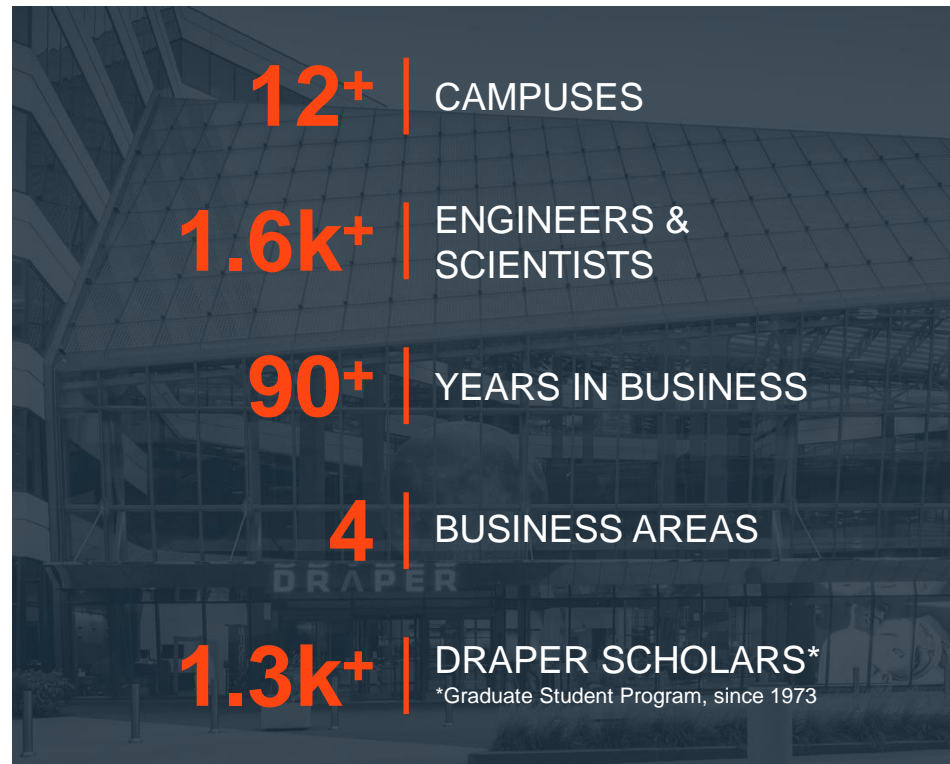
Agenda

- About Draper
- Quantifying the Qualitative
- Evidence
- Considerations: Ethics, Equity, and Equality
- Next Steps and How We Can Work Together

Draper Overview

We are a nonprofit engineering innovation company at the Intersection of USG, academia, and industry.

- Next generation innovators
- Solve complex challenges
- Serve the nation's security needs
- Objective focus on customers' vision



Draper Capabilities



Inertial measurement



Guidance, navigation and control



Physical sensing and timing



High assurance systems



Design for harsh environments



Complex system miniaturization



Communications and Radio Frequency systems



Cyber-physical systems security



Human-system engineering



Data analytics and machine learning



Autonomy and perception software



Electromechanical systems



Organ on a chip



Bioprocessing and synthetic biology

Quantifying the Qualitative

Quantifying the Qualitative

Quantitatively and Robustly Assess and Predict a Person's State

- Determine mental health or physical health issue that needs to be treated
-
- Evaluate risks
-
- Provide information to aid decision making and improve outcomes

Challenges

Humans are messy...

- Forgetfulness
- Truthfulness
- Stress and anxiety
- Mistakes



Measures

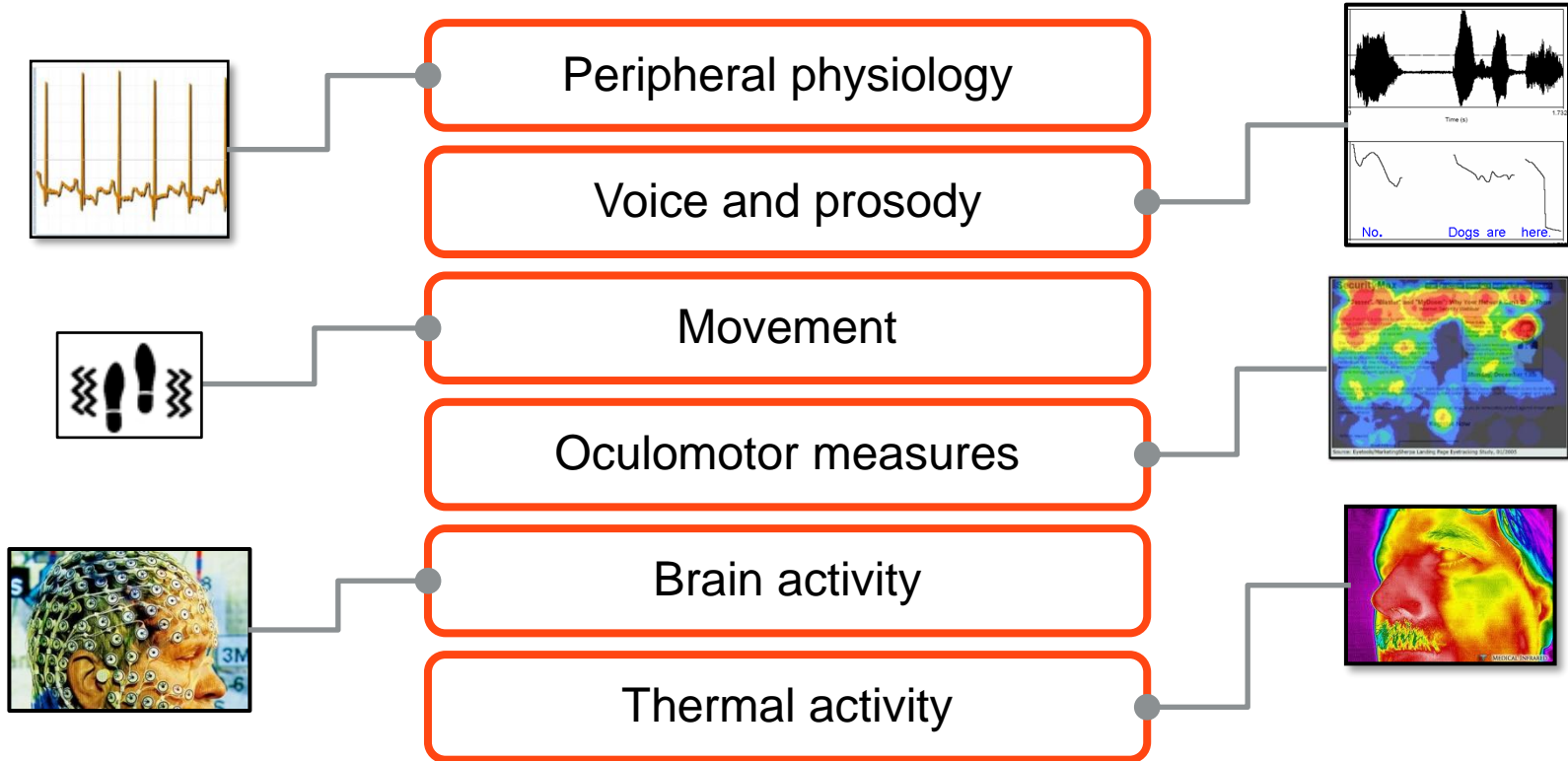
Self-Report Measures: *Gold Standard*

- Time intensive
- Interruptive
- Not always fully accurate

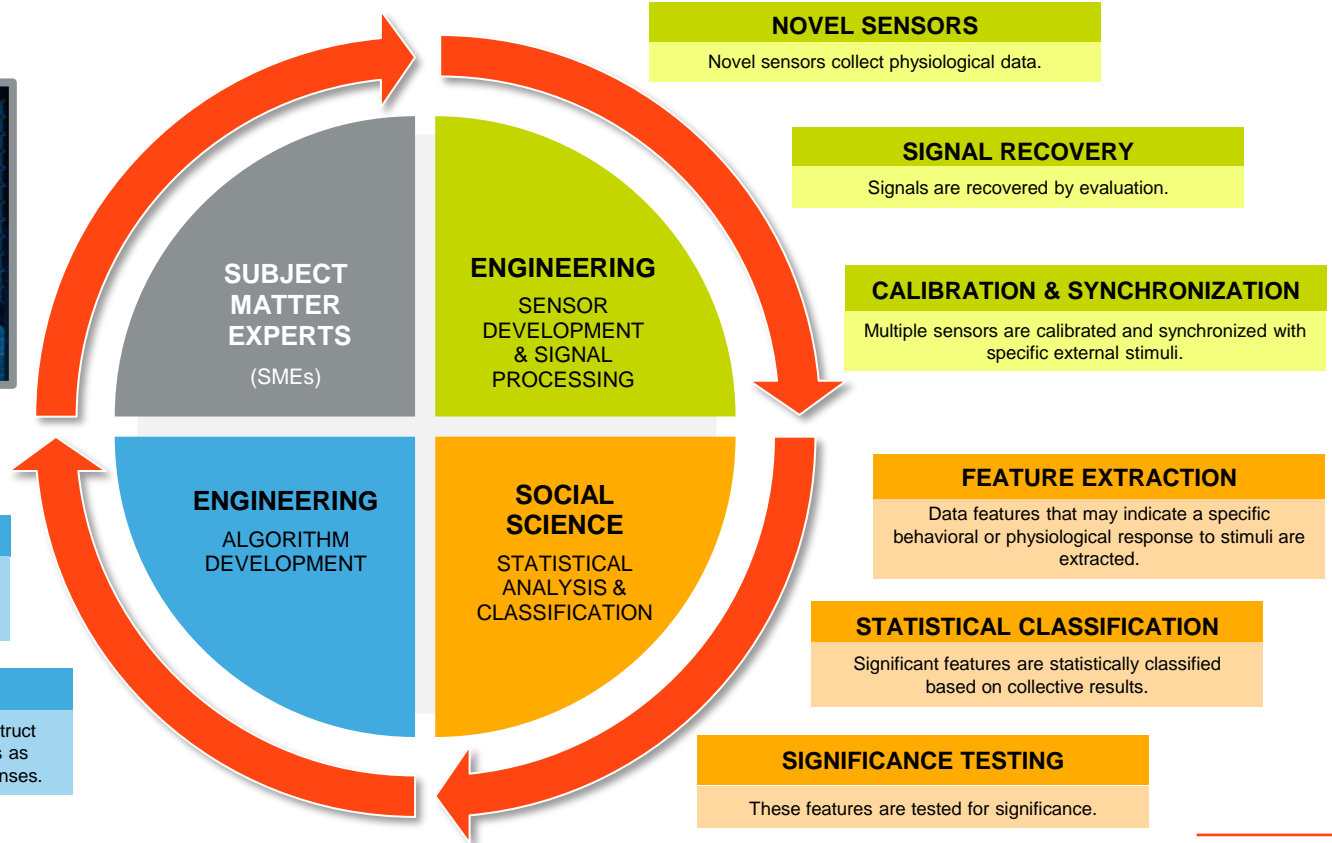
Other Types of Measures

- Less invasive
- Continuous
- Objective
- Multi-modal

Physiometric Measures to Address Challenges



Human Signals and Systems Approach



Assessment Challenges



Healthcare Provider

- Diagnostic speed and accuracy
- Treatment selection and monitoring

Patient

- Awareness and access
- Treat and repeat

Healthcare System

- Short- and long-term costs
- Outcomes

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Evidence

Posttraumatic Stress Disorder (PTSD)

Measure	Baseline	Startle	Standard Trauma	Idiographic Trauma
Aggregate	✓	✓	✓	✓
Eyeblink	ns	✓		
Zygomaticus EMG	ns		ns	
Frontalis EMG	ns		ns	✓
Corrugator EMG	ns		ns	✓
Heart rate	✓	✓	✓	✓
Skin conductance	✓	✓	✓	✓
Systolic BP	✓		ns	ns
Diastolic BP			ns	✓
Agg habituation		✓		
Eyeblink slope, habituation		ns		
SC slope		✓		
SC habituation		ns		
Heart rate slope		ns		
Prepulse inhibition		ns		

Measurable Physiological Changes to Stimuli

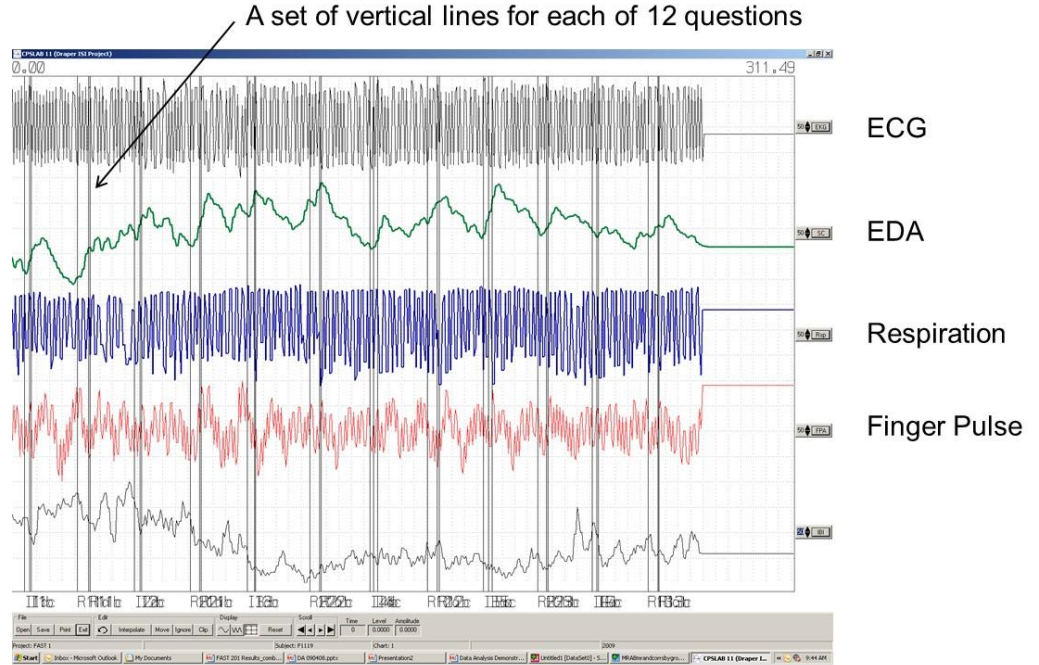


- Resting heart rate, skin conductance & blood pressure
 - HR, eye blink & SC responses to loud tones
 - HR & SC responses to standardized trauma cues
 - Facial muscle, HR, & SC responses to idiographic trauma cues
 - Diastolic blood pressures response to idiographic trauma cues
-



- SC habituation to loud tones

Multimodal Approach



Psychophysiological-based system designed to provide multimodal, objective, quantitative indicators of mental health

Proof-of-concept studies with this platform

1

Post-Traumatic Stress Disorder (PTSD) diagnosis

2

Major Depressive Disorder (MDD) diagnosis

3

PTSD treatment monitoring

Studies Focused on PTSD

Diagnosis in combat veterans

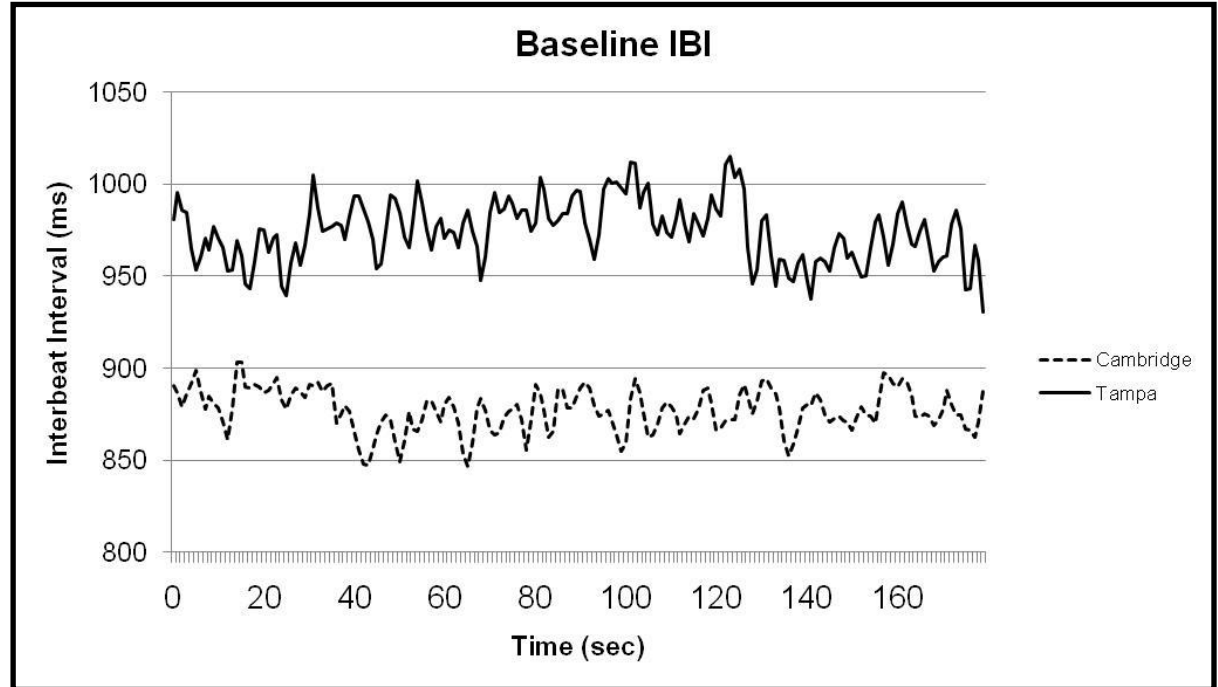
- Measures
 - Electrodermal activity
 - Electrocardiogram
 - Respiration
 - Peripheral vasomotor activity
- Protocol
 - Baseline with white noise startle
 - Emotionally evocative images and sounds
 - VR videos in which non-idiographic stimuli of increasing intensity are presented

Therapeutic monitoring in civilians

- Measures
 - Respiration and cardiac
 - Electrodermal activity
 - Pupil diameter
- Protocol (pre- and post-treatment)
 - Baseline with loud tone startle
 - Standardized math stressor
 - Emotionally evocative images
 - Emotionally evocative scripts
 - Standard and individualized Neutral and Trauma

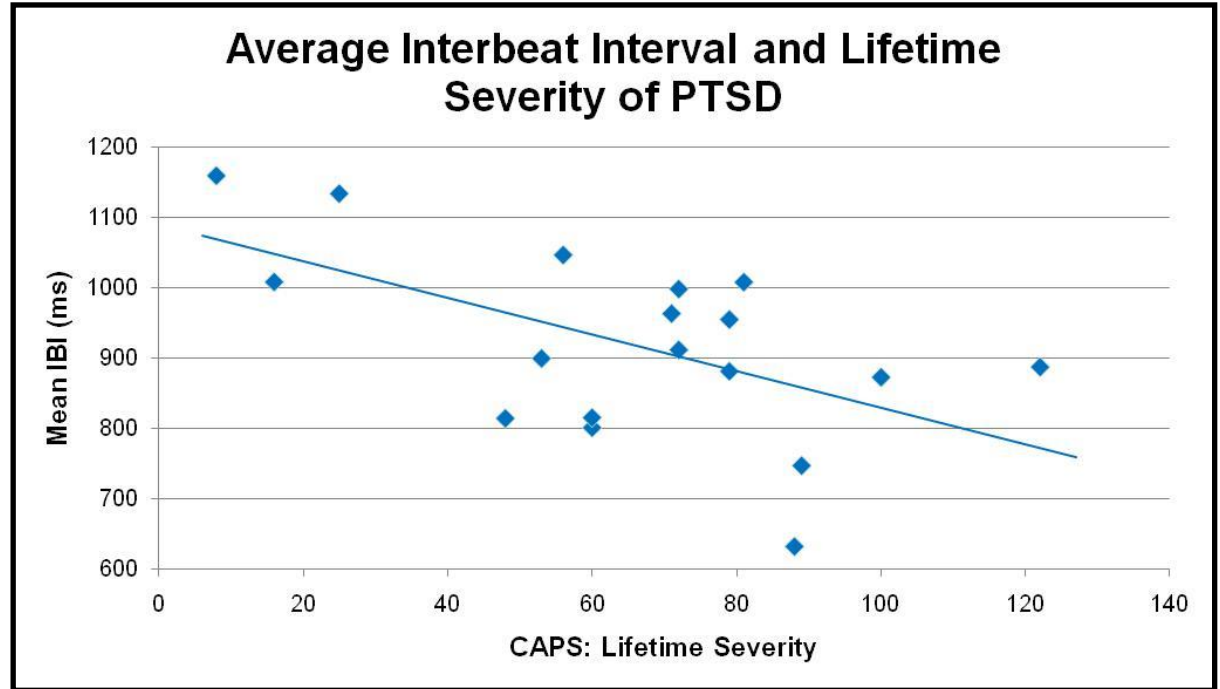
Baseline Cardiac Results

Those in **Cambridge** tended to have a **higher heart rate** than those in **Tampa**.

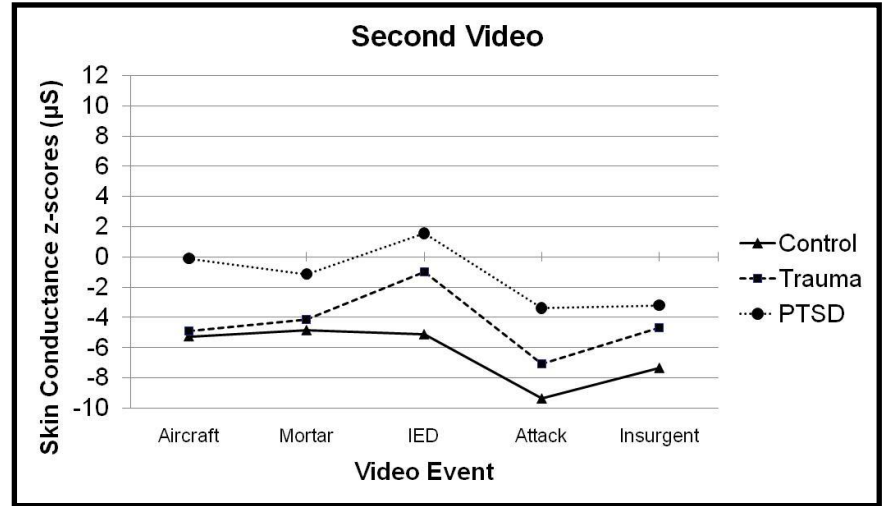
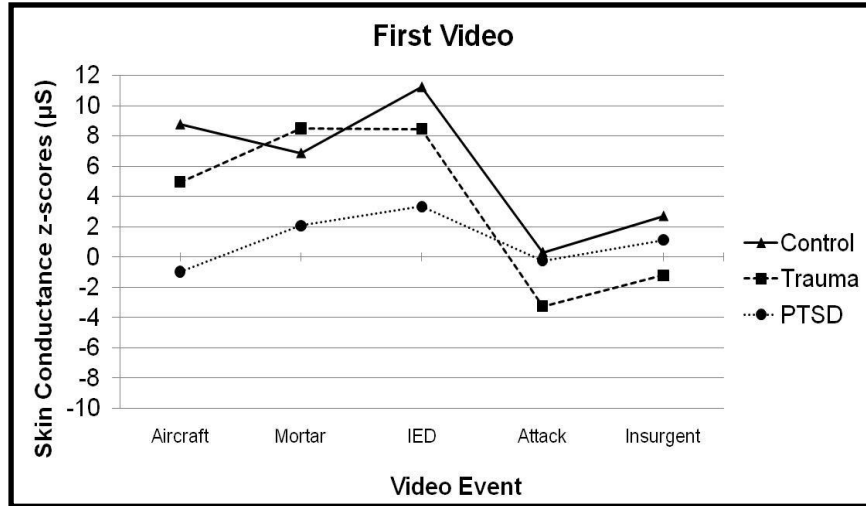


Heart Rate and PTSD Severity

Those with more **severe PTSD** generally had a **higher heart rate**.



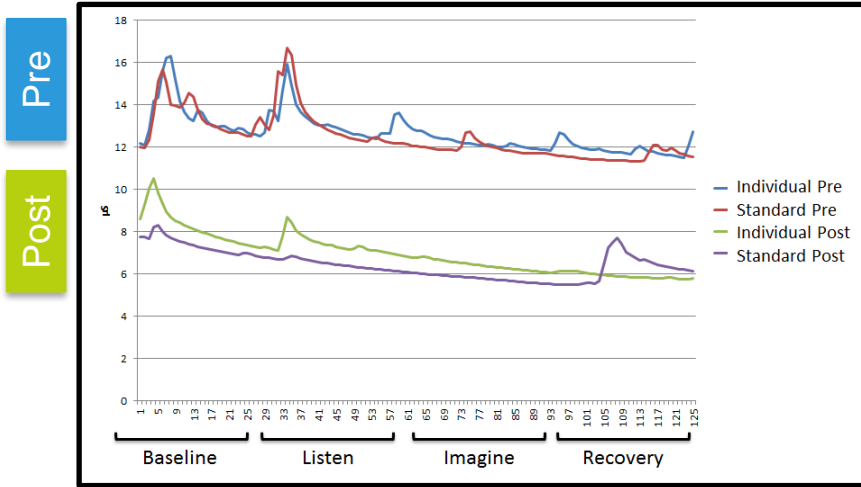
Group Differences in Electrodermal Reactivity



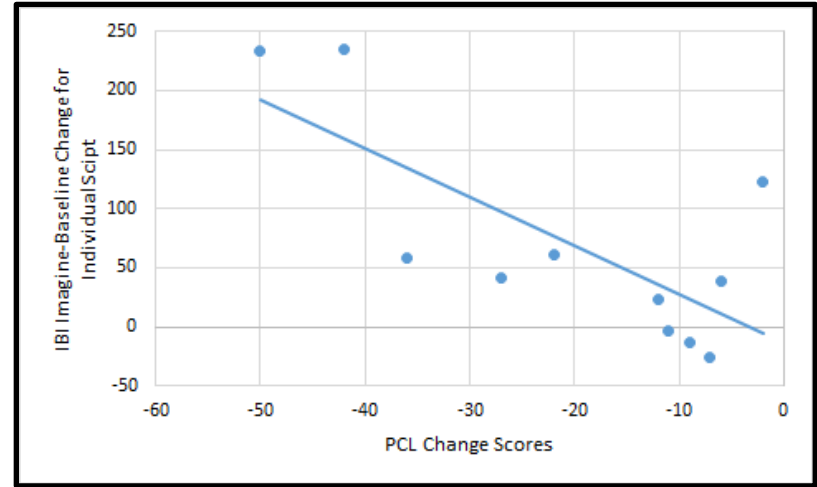
Skin conductance responses did not habituate for those with PTSD.

Therapeutic Monitoring in Civilians

Single subject example

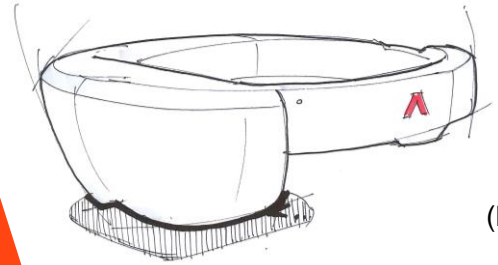


Physiological & clinical change

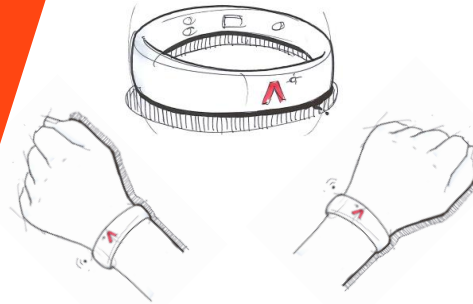


$$r = -.81, p < .01$$

Translating from Research to Clinical Care



HEADSET
Eye tracking
Stimuli
(Low Distraction, Immersion)



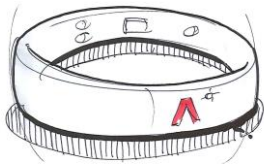
WEARABLES:
2 wrist, 1 ankle

ECG
Heart Rate
EDA
(Non-intrusive)

Vision Spans the Continuum of Care

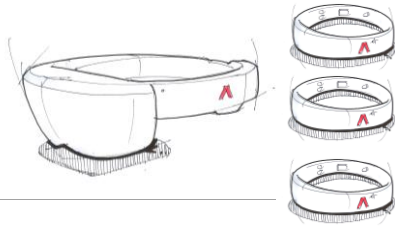
PRE-SCREEN

- Capture patient data “in the wild” to record event triggers
- Use low fidelity data to develop baseline



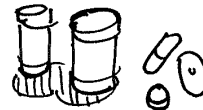
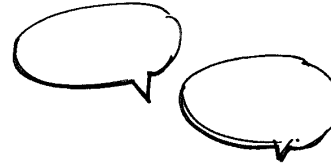
CLINICAL DIAGNOSTIC

- Provide objective, accurate confirmation of diagnosis
- Run full clinical diagnostic with high fidelity inputs



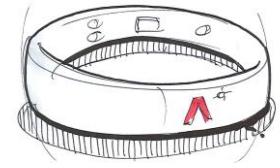
TREATMENT SELECTION

- Review clinical diagnostic to identify and guide appropriate type of treatment and dosing schedule



TREATMENT MONITORING

- Review treatment plan and patient progress over time
- Adjust any medications, dosing, frequency if needed



Considerations: Ethics, Equity, and Equality?

Use of Technology in Healthcare

“ What hardware and software may be used? How much physical space is needed? Is it easy to acquire? Easy to transport? Easy to use? Training needed? Oversight and regulation?

“ Who is using it? Are the results clinician-facing, patient-facing? How will the results be used?

“ How do we ensure that the technology fits into someone's workflow?

“ Are there unintended uses for the technology or the results?

“ How easy is it to ensure equitable access and use?

Next Steps & How We Can Work Together

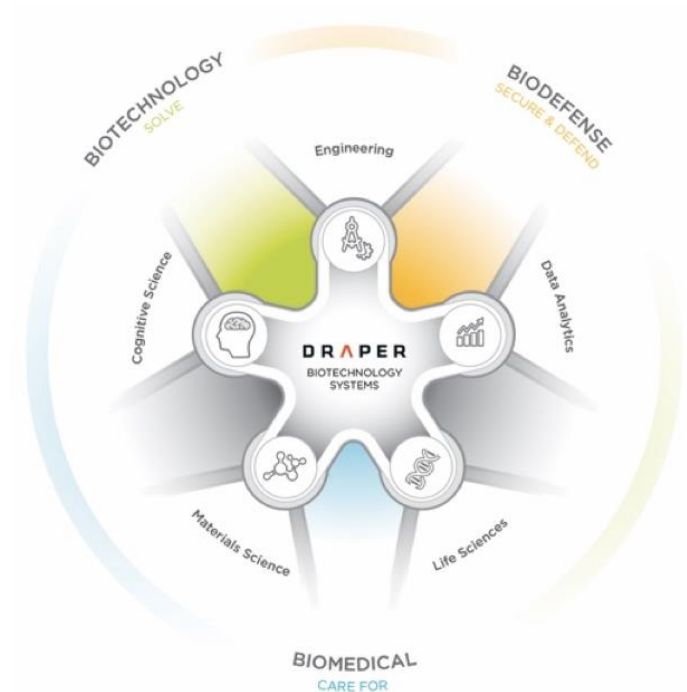
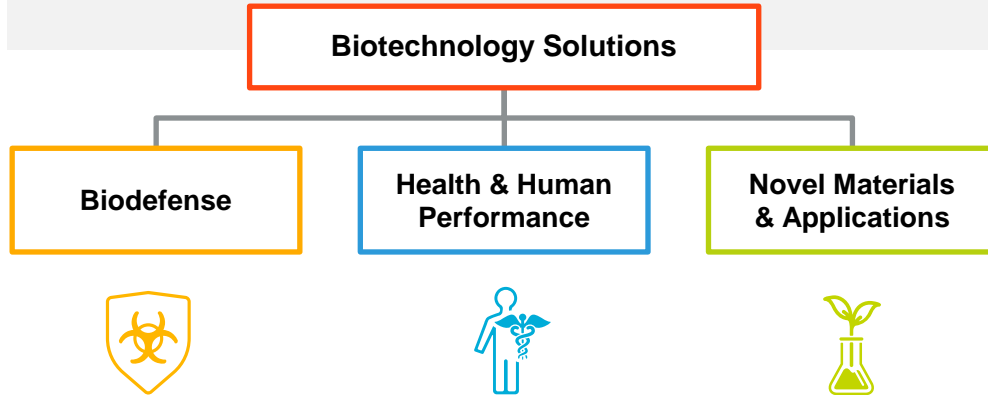
Conclusion

- Quantify humans, at least to some extent
- Use objective, quantitative measures to better understand humans
- Provide end users with additional data sources to inform their decision making
- Start moving toward new and improved gold standards to improve the accuracy and reliability of decisions
- Much remains to be done and a multidisciplinary approach is needed

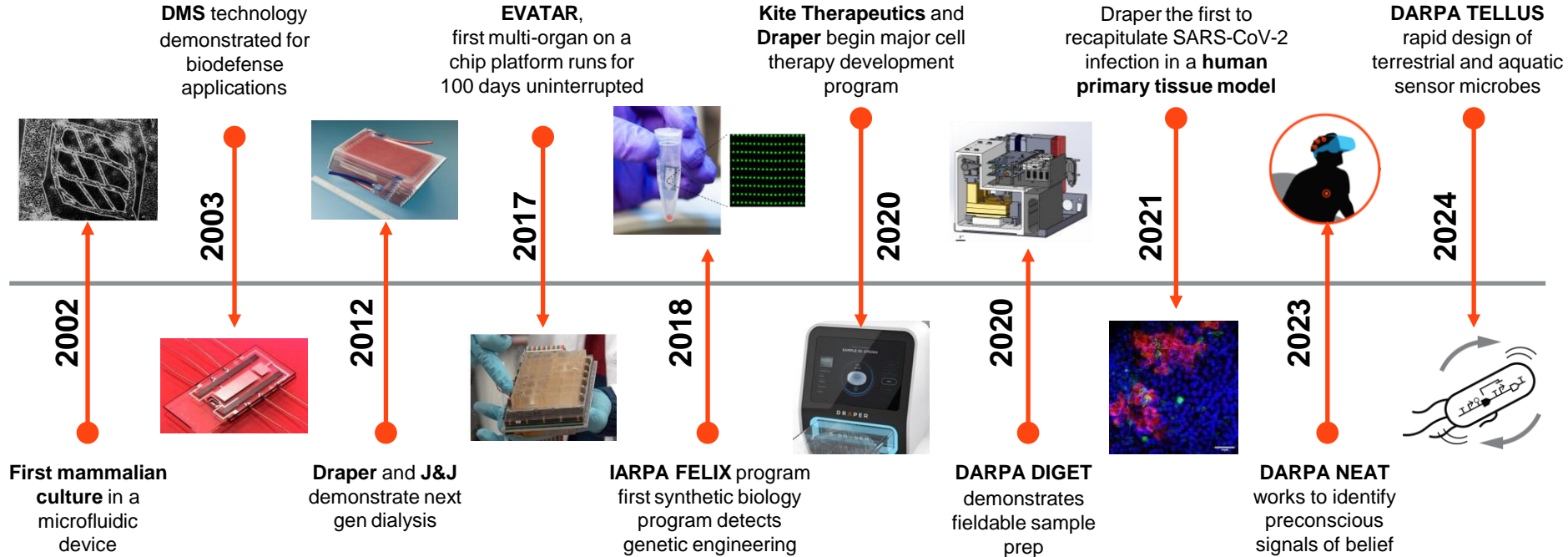
Draper Biotechnology Solutions

Mission

Empowering National Security through the development and delivery of biotechnology inspired solutions that safeguard our nations' security and enrich people's lives on behalf of current and future generations.



Past and Current Efforts to Build Upon



First-of-a-kind milestones at convergence of Engineering and Biology

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Thank You!