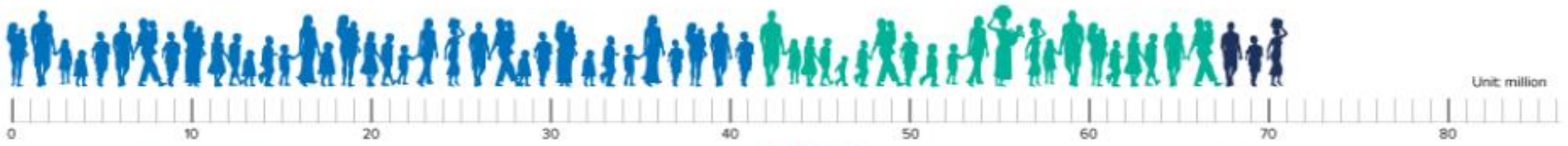
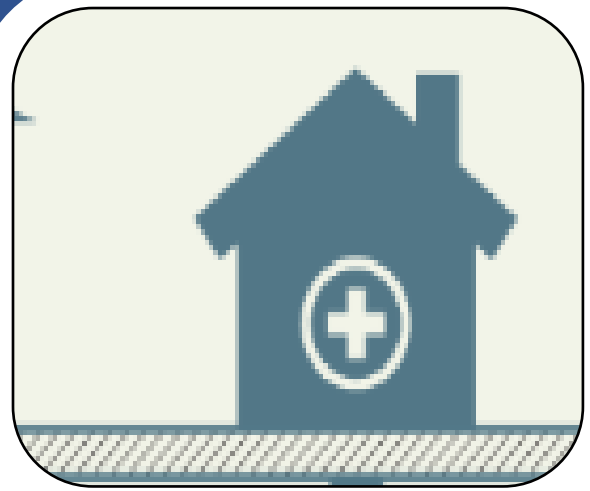
**70.8 million** forcibly displaced people worldwide

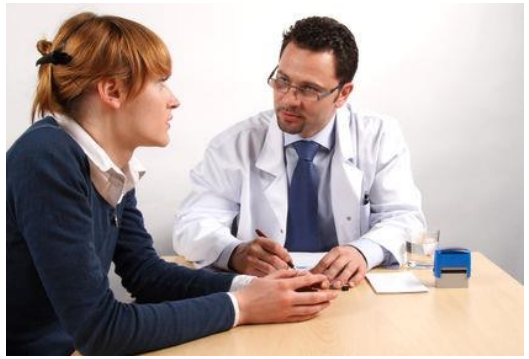



20.4 million under UNHCR's mandate
5.5 million Palestinian refugees under UNRWA's mandate

https://www.independent.co.uk/topic/refugee
https://www.unhcr.org/uk/figures-at-a-glance.html

# Mental Health Care Scarcity



Karunakara, Unni Krishnan, et al. "Traumatic events and symptoms of post-traumatic stress disorder amongst Sudanese nationals, refugees and Ugandans in the West Nile." *African health sciences* 4.2 (2004): 83-93.

# Standard Treatment

# Research Frontier: Electroencephalogram (EEG)

## Research Question

Can we improve access to PTSD screening with a low cost, fast and flexible automated wearable system?

## Resources

The **MINI** Questionnaire

$112 NeuroSky Mindwave

# Two Tell-tale Perspectives of PTSD: Neurobiological Abnormalities and Bayesian Regulatory Network of the Underlying Disorder in a Refugee Context

Farhana Shahid, **Wasifur Rahman** , Anika Binte Islam, Nipi Paul, Nabila Khan, Mohammad Saifur Rahman, Md Munirul Haque, and A. B. M. Alim Al Islam

# Goals

Detecting Relevant EEG Signals

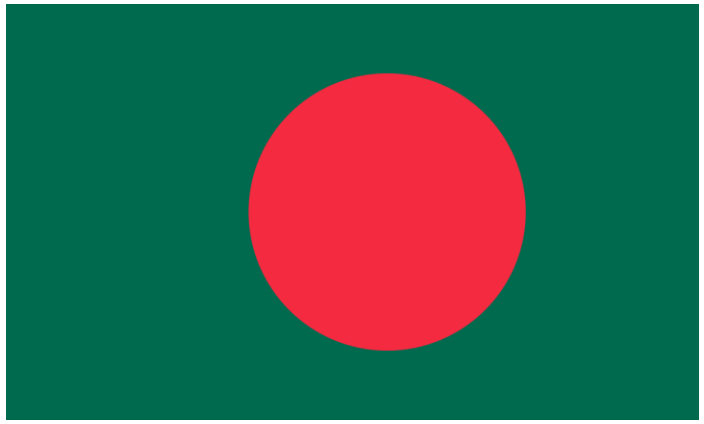
Bayesian Model

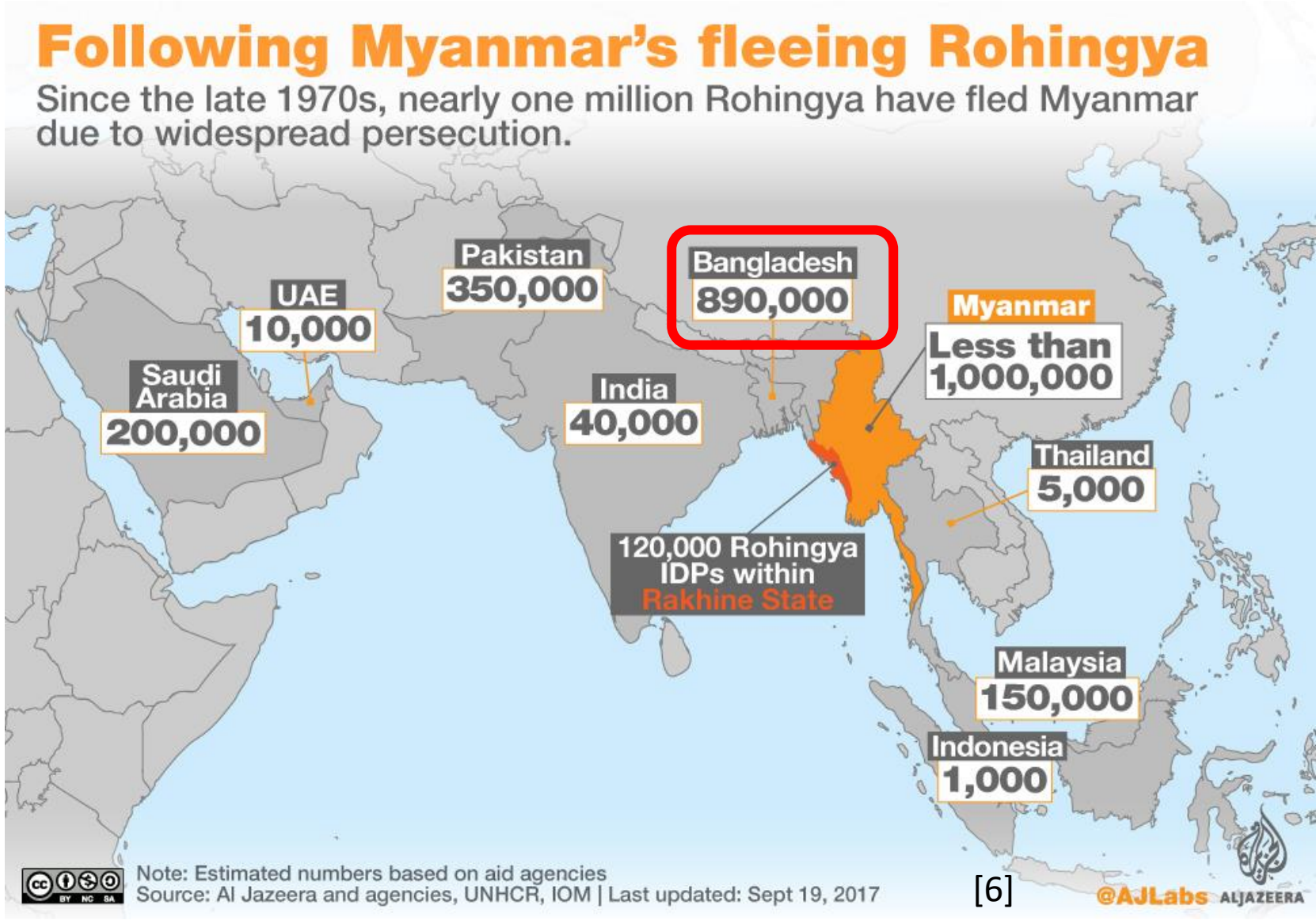
Validation

Future Work

Guidance

# Refugee Population






[6]

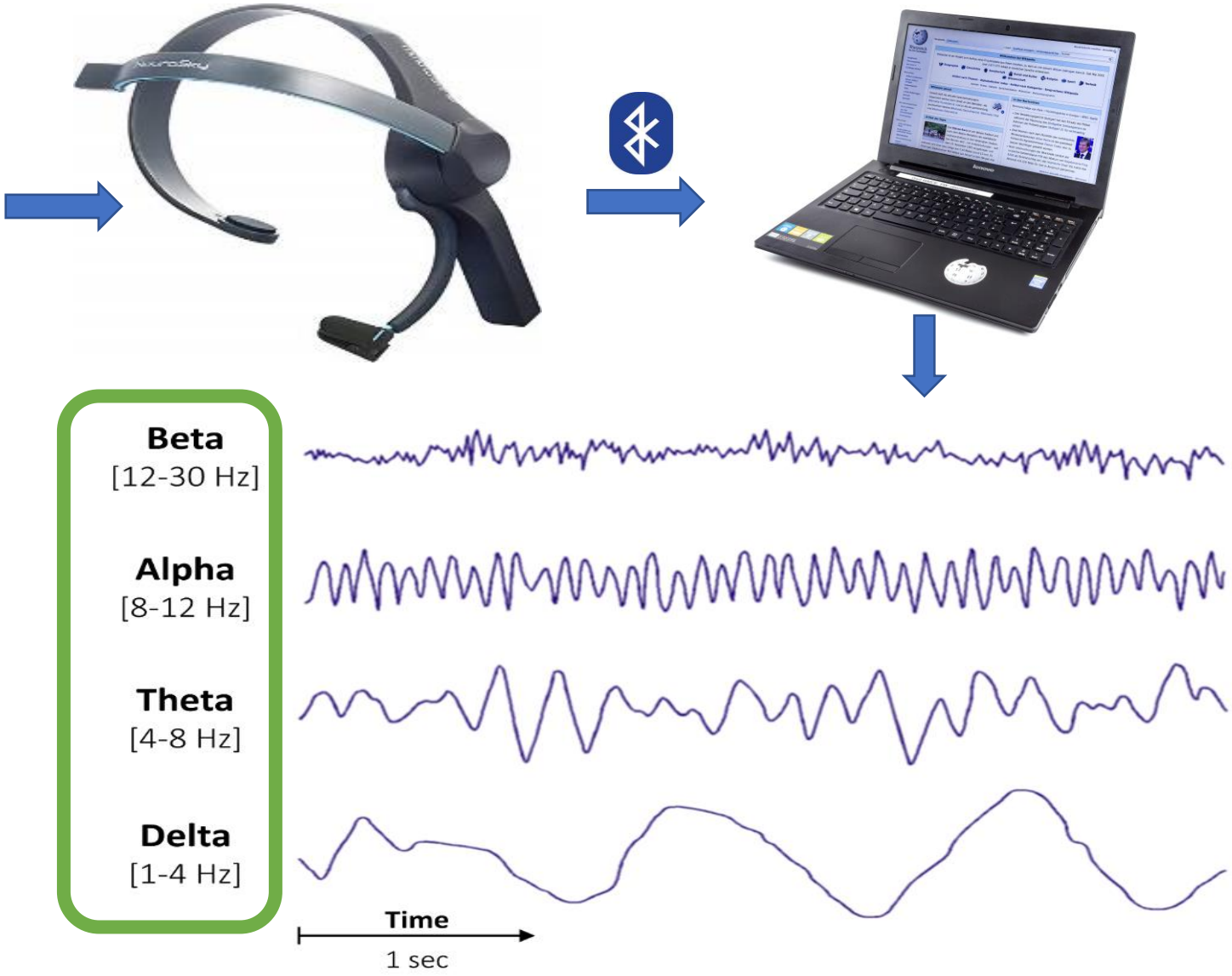
# Refugee Camp

[7]

# Interview


Data Collection in Rohingya Camp

# EEG Data Collection




https://en.wikipedia.org/wiki/Laptop#/media/File:Lenovo_G500s_laptop-2905.jpg
https://raphaelvallat.com/bandpower.html

# MINI Data Collection

The Mini-International Neuropsychiatric Interview (MINI)

Sheehan, David V., et al. "The Mini-International Neuropsychiatric Interview (MINI): the development and validation of a structured diagnostic psychiatric interview for DSM-IV and ICD-10." *The Journal of clinical psychiatry* (1998).

Compatible with both ICD-10 and DSM-V disorders

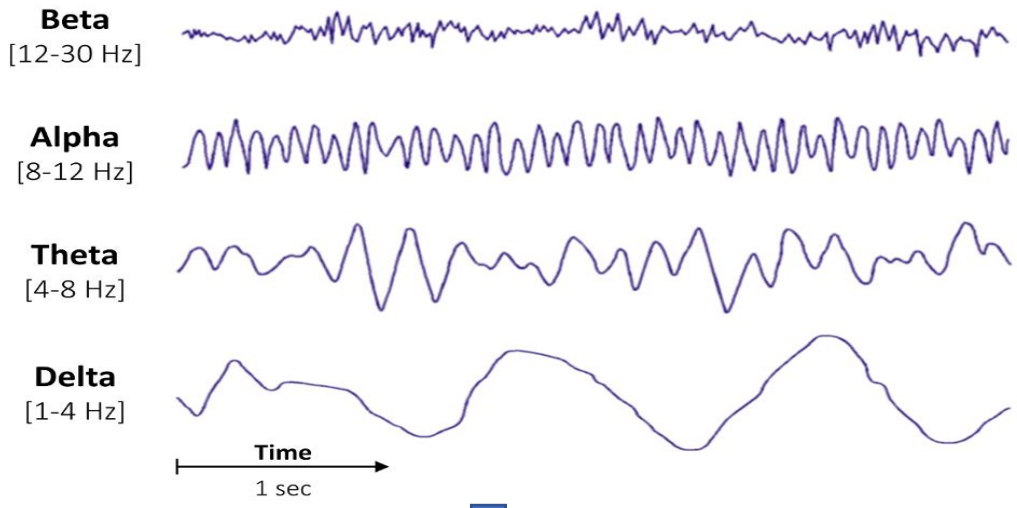
PTSD Module


Q4: Do you have trouble recalling exactly what had happened?

Probable PTSD

# Data Overview

#Control = 45
#PTSD refugee= 49




1. **PTSD** as defined by **MINI**
2. Feeling **distressed**
3. **Nightmare**
4. **Avoiding** trauma-related stimuli
5. Inability to **recall** key features of trauma
6. Difficulty in **sleeping**
7. **Irritability**
8. Difficulty in **concentrating**
9. Feeling **nervous**

# Validation

| | Low Alpha | High Alpha | Low Beta | High Beta | Mid Gamma |
|---|---|---|---|---|---|
| PTSD | | | | | |
| Distress | | | | | |
| Nightmare | | | | | |
| Avoidance | | | | | |
| Recall Inability | | | | | |
| Sleeping Difficulty | | | | | |
| Irritability | | | | | |
| Concentration Difficulty | | | | | |
| Nervousness | | | | | |

**Only showing entries with p <0.01 after Benjamini-Hochberg multiple test correction**

Thissen D, Steinberg L, Kuang D. Quick and easy implementation of the Benjamini-Hochberg procedure for controlling the false positive rate in multiple comparisons. Journal of educational and behavioral statistics. 2002 Mar;27(1):77-83.
NeuroSky. 2015. Greek Alphabet Soup - Making Sense of EEG Bands. Retrieved September 14, 2018 from http://neurosky.com/2015/05/ greek-alphabet-soup-making-sense-of-eeg-bands/

# Validation

| | Low Alpha | High Alpha | Low Beta | High Beta | Mid Gamma |
|---|---|---|---|---|---|
| PTSD | ↓ | | | | |
| Distress | ↓ | | | | |
| Nightmare | | | | | |
| Avoidance | | | | | |
| Recall Inability | | | | | |
| Sleeping Difficulty | ↓ | | | | |
| Irritability | | | | | |
| Concentration Difficulty | | | | | |
| Nervousness | ↓ | | | | |

**Only showing entries with p <0.01 after Benjamini-Hochberg multiple test correction**

↓ Low Alpha ~ Anxiety, High Stress, Insomnia

NeuroSky. 2015. Greek Alphabet Soup - Making Sense of EEG Bands. Retrieved September 14, 2018 from http://neurosky.com/2015/05/ greek-alphabet-soup-making-sense-of-eeg-bands/

# Validation

| | Low Alpha | High Alpha | Low Beta | High Beta | Mid Gamma |
|---|---|---|---|---|---|
| PTSD | ↓ | | | | |
| Distress | ↓ | ↓ | | | |
| Nightmare | | ↓ | | | |
| Avoidance | | | | | |
| Recall Inability | | ↓ | | | |
| Sleeping Difficulty | ↓ | | | | |
| Irritability | | | | | |
| Concentration Difficulty | | | | | |
| Nervousness | ↓ | ↓ | | | |

**Only showing entries with p <0.01 after Benjamini-Hochberg multiple test correction**

High Alpha ~ Lower Anxiety, Increased Calmness, Good Cognitive Memory

Baruch Rael Cahn and John Polich. 2006. Meditation states and traits: EEG, ERP, and neuroimaging studies. Psychological Bulletin 132, 2 (2006),180–211.
Wolfgang Klimesch. 1999. EEG alpha and theta oscillations reflect cognitive and memory performance: a review and analysis. Brain Research Reviews29,2(1999),169–195

# Validation

| | Low Alpha | High Alpha | Low Beta | High Beta | Mid Gamma |
|---|---|---|---|---|---|
| PTSD | ↓ | | ↑ | | |
| Distress | ↓ | ↓ | ↑ | | |
| Nightmare | | ↓ | ↑ | | |
| Avoidance | | | | | |
| Recall Inability | | ↓ | ↓ | | |
| Sleeping Difficulty | ↓ | | ↑ | | |
| Irritability | | | | | |
| Concentration Difficulty | | | ↑ | | |
| Nervousness | ↓ | ↓ | ↑ | | |

**Only showing entries with p <0.01 after Benjamini-Hochberg multiple test correction**

↑ Low Beta ~ PTSD, Insomnia, Anxiety, Stress, Inattention, **Memory-Promoting state**


Dražen Begić, Ljubomir Hotujac, and Nataša Jokić-begić. 2001. Electroencephalographic comparison of veterans with combat-related post-traumaticstressdisorderandhealthysubjects.InternationalJournalofPsychophysiology40,2(2001),167–172.
Michael L. Perlis, Michael T. Smith, Patrick J. Andrews, Henry Orff, and Donna E. Giles. 2001. Beta/Gamma EEG Activity in Patients with PrimaryandSecondaryInsomniaandGoodSleeperControl
NeuroSky. 2015. Greek Alphabet Soup - Making Sense of EEG Bands. Retrieved September 14, 2018 from http://neurosky.com/2015/05/ greek-alphabet-soup-making-sense-of-eeg-bands/

# Validation

| | Low Alpha | High Alpha | Low Beta | High Beta | Mid Gamma |
|---|---|---|---|---|---|
| PTSD | ↓ | | ↑ | | |
| Distress | ↓ | ↓ | ↑ | | |
| Nightmare | | ↓ | ↑ | | |
| Avoidance | | | | | |
| Recall Inability | | ↓ | ↓ | ↓ | |
| Sleeping Difficulty | ↓ | | ↑ | | |
| Irritability | | | | | |
| Concentration Difficulty | | | ↑ | | |
| Nervousness | ↓ | ↓ | ↑ | ↓ | |

**Only showing entries with p <0.01 after Benjamini-Hochberg multiple test correction**

↑ High Beta ~ **Nervousness, Memory-Promoting state**

Andreas K. Kaiser, Michael Doppelmayr, and Bernhard Iglseder. 2017. EEG beta 2 power as surrogate marker for memory impairment: a pilotstudy.InternationalPsychogeriatrics29,9(2017),1–9.
Leslie Sherlin, Fred Muench, and Sarah Wyckoff. 2010. Respiratory Sinus Arrhythmia Feedback in a Stressed Population Exposed to a Brief Stressor Demonstrated by Quantitative EEG and sLORETA. Applied Psychophysiology and Biofeedback 35, 3 (2010), 219–228

# Validation

| | Low Alpha | High Alpha | Low Beta | High Beta | Mid Gamma |
|---|---|---|---|---|---|
| PTSD | ↓ | | ↑ | | ↓ |
| Distress | ↓ | ↓ | ↑ | | ↓ |
| Nightmare | | ↓ | ↑ | | ↓ |
| Avoidance | | | | | ↓ |
| Recall Inability | | ↓ | ↓ | ↓ | ↓ |
| Sleeping Difficulty | ↓ | | ↑ | | ↓ |
| Irritability | | | | | ↓ |
| Concentration Difficulty | | | ↑ | | ↓ |
| Nervousness | ↓ | ↓ | ↑ | ↓ | ↓ |

**Only showing entries with p <0.01 after Benjamini-Hochberg multiple test correction**

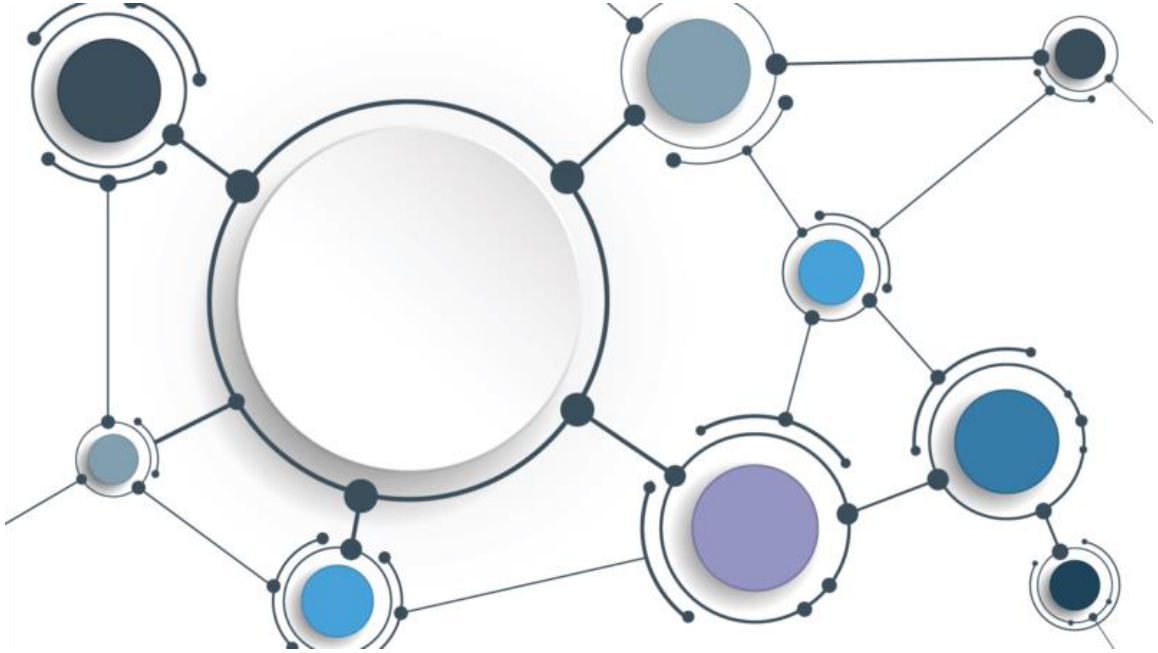
↓ gamma ~ Sleeping disturbances, attention deficiency


Andreas K. Kaiser, Michael Doppelmayr, and Bernhard Iglseder. 2017. EEG beta 2 power as surrogate marker for memory impairment: a pilotstudy.InternationalPsychogeriatrics29,9(2017),1–9.
Leslie Sherlin, Fred Muench, and Sarah Wyckoff. 2010. Respiratory Sinus Arrhythmia Feedback in a Stressed Population Exposed to a Brief Stressor Demonstrated by Quantitative EEG and sLORETA. Applied Psychophysiology and Biofeedback 35, 3 (2010), 219–228

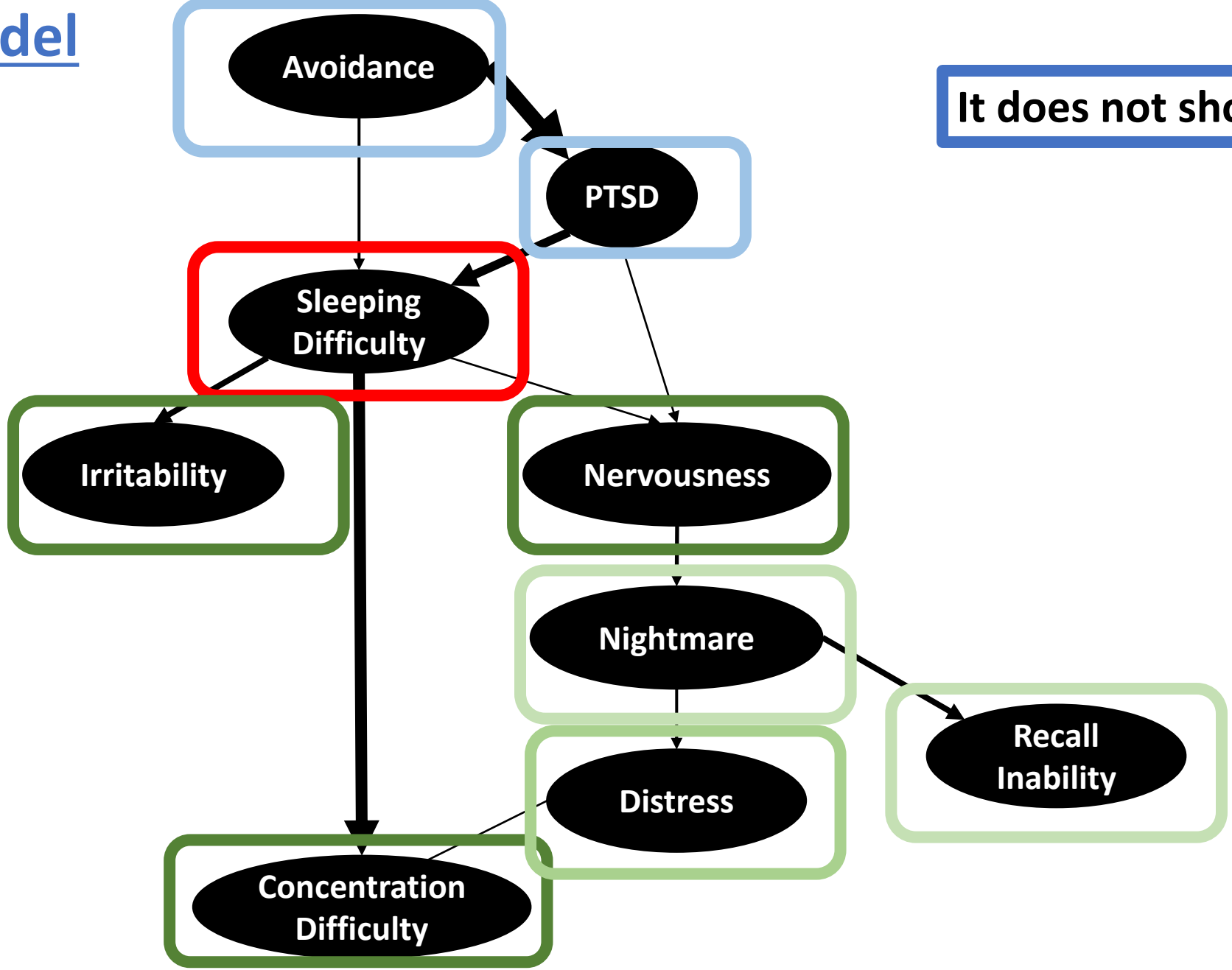
# Why Contradiction?

https://www.utoronto.ca/news/new-technique-developed-u-t-uses-eeg-show-how-our-brains-perceive-faces


POST
TRAUMATIC
STRESS
DISORDER



# Bayesian Model




It does not show causation

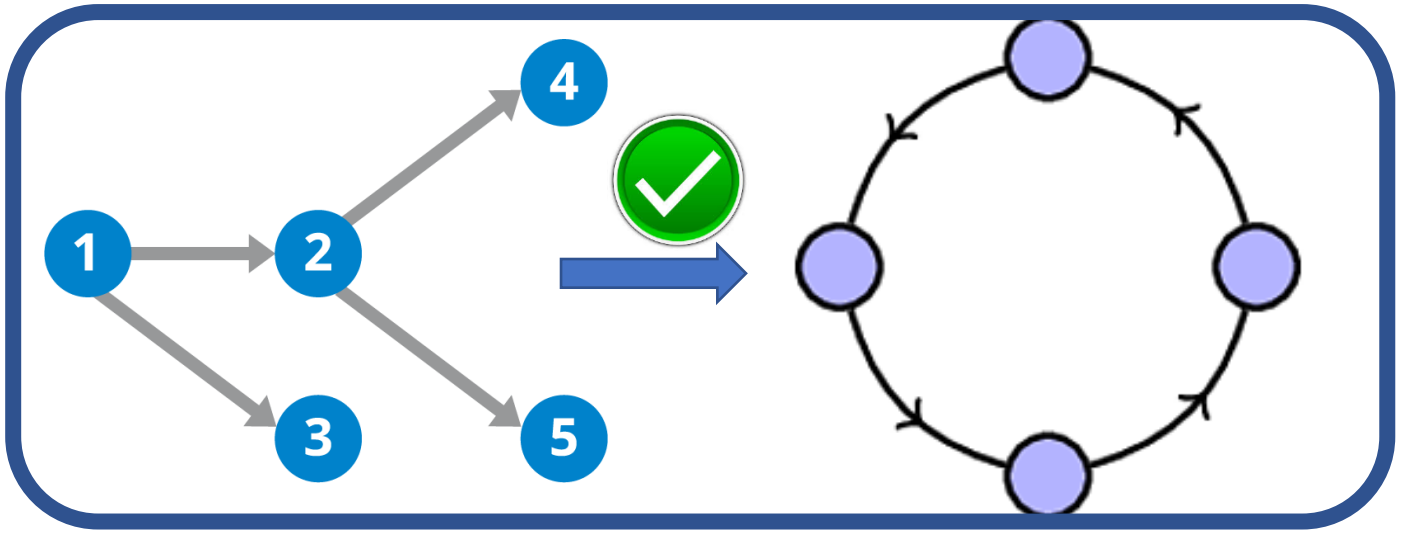
# Take Home Message


Koffel, Erin, Imran S. Khawaja, and Anne Germain. "Sleep disturbances in posttraumatic stress disorder: updated review and implications for treatment." *Psychiatric annals* 46.3 (2016): 173-176.

Ulmer, Christi S., Jack D. Edinger, and Patrick S. Calhoun. "A multi-component cognitive-behavioral intervention for sleep disturbance in veterans with PTSD: a pilot study." *Journal of Clinical Sleep Medicine* 7.01 (2011): 57-68.

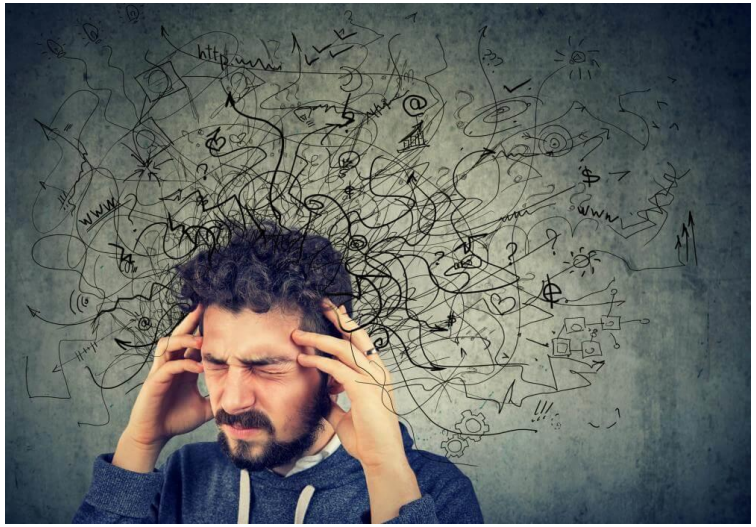
Vandrey, Ryan, et al. "Interactions between disordered sleep, post-traumatic stress disorder, and substance use disorders." *International Review of Psychiatry* 26.2 (2014): 237-247.

# Future Works




Cyclic Structure

Better device ➡ Better Data



More-intuitive design

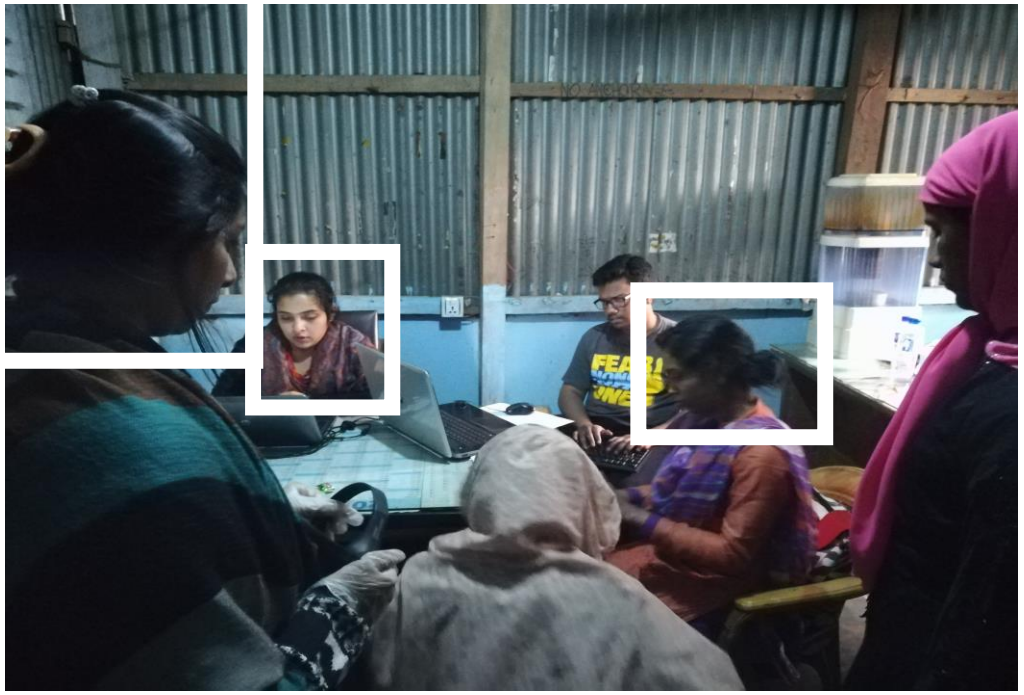
https://www.blastam.com/data-quality-assurance
https://steemit.com/bitcoin/@chitty/bitcoin-maximalists-are-confused-af-right-now
https://hazelcast.com/glossary/directed-acyclic-graph/

# Research Guidance

Diversity

Language Barrier

Rapport



Gender Participation

https://uniontestprep.com/cna/blog/patient-differences-religious-ethnic-and-cultural

# Summary

- A low-cost, fast and flexible system for identifying PTSD-related EEG signals
- Validated by pilot study with Rohingya refugees.
- Findings are largely in agreement with the prior research.
- Bayesian network to understand PTSD symptoms.
- Opening the door towards detecting PTSD with wearable device only.

# Two Tell-tale Perspectives of PTSD: Neurobiological Abnormalities and Bayesian Regulatory Network of the Underlying Disorder in a Refugee Context

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# References


1. https://www.huffingtonpost.co.uk/entry/rohingya-crisis-photos_n_5a3bc302e4b025f99e150f1d?guccounter=1
2. https://en.wikipedia.org/wiki/Myanmar#/media/File:Myanmar_-_Location_Map_(2013)_-_MMR_-_UNOCHA.svg
3. https://www.bbc.co.uk/news/uk-politics-27295412
4. https://www.legal-malta.com/news/dangers-of-acquiring-citizenship-by-investment
5. https://www.bbc.co.uk/news/world-11108059
6. https://www.aljazeera.com/indepth/features/2017/08/rohingya-muslims-170831065142812.html
7. https://www.japantimes.co.jp/news/2018/04/17/asia-pacific/social-issues-asia-pacific/conditions-worsening-700000-rohingya-refugees-coxs-bazar-ahead-monsoon-rains/#.XXURbZNKjMU