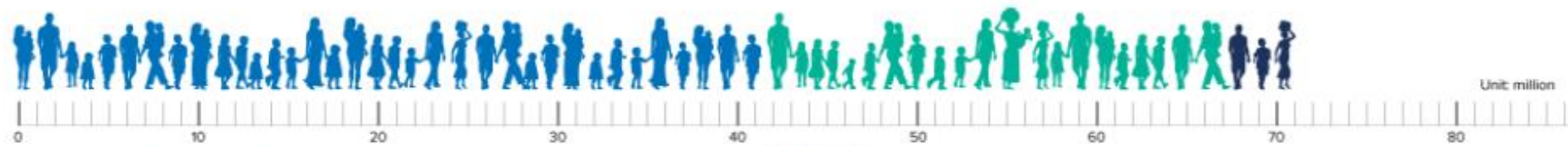




70.8 million forcibly displaced people worldwide



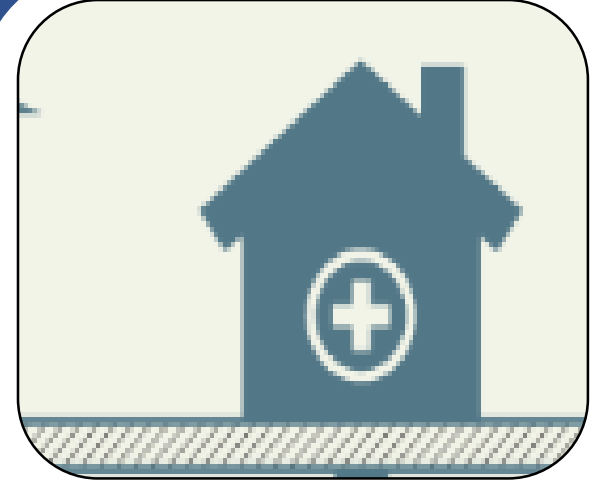
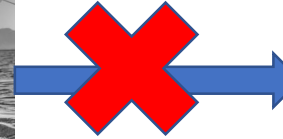
20.4 million under UNHCR's mandate

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

POST
TRAUMATIC
STRESS
DISORDER



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

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Goals

Detecting Relevant EEG Signals

Bayesian Model

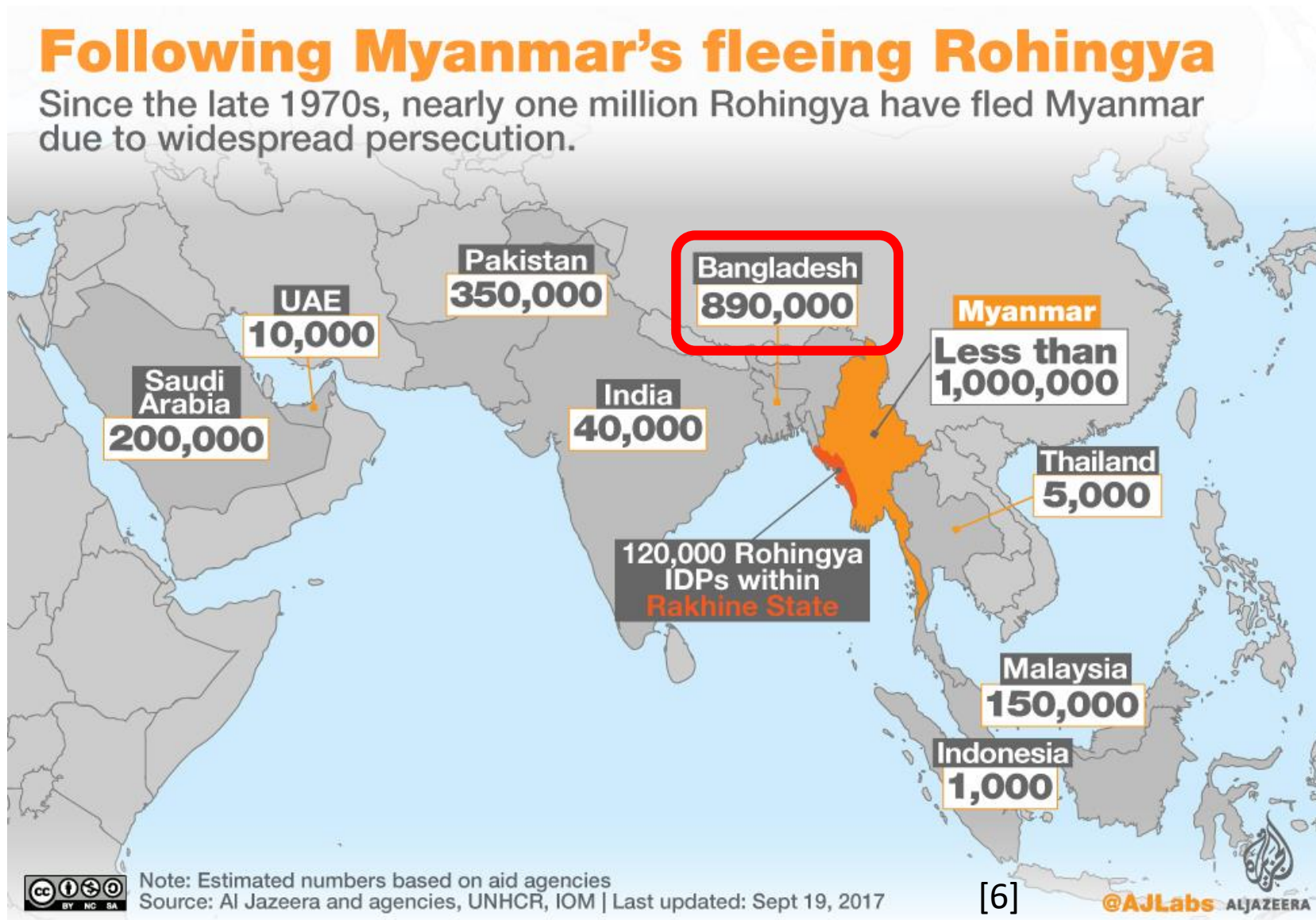
Validation

Future Work

Guidance



Refugee Population



Refugee Camp



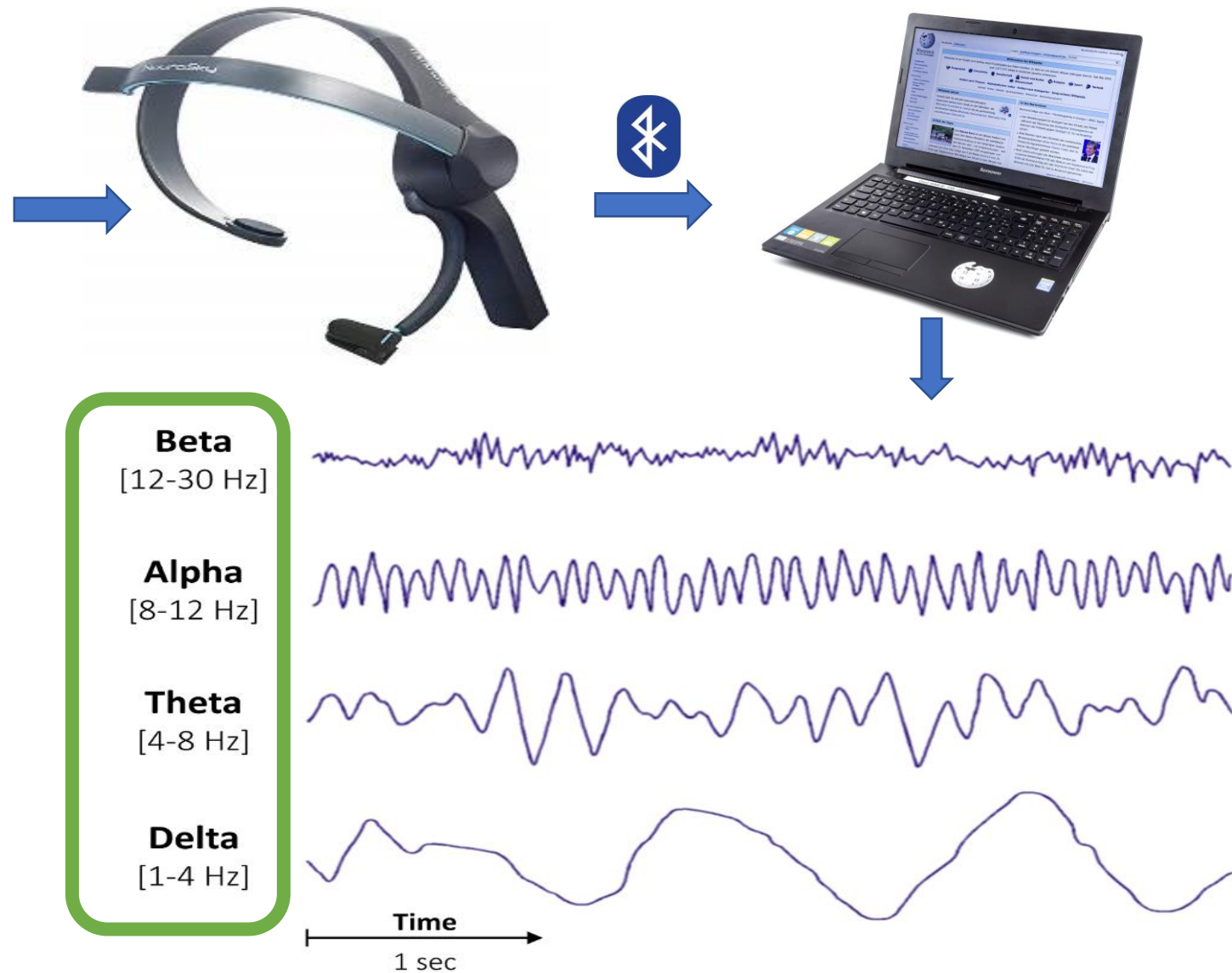
[7]

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 **M**ini-**I**nternational **N**europsychiatric **I**nterview (**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**



Beta
[12-30 Hz]



Alpha
[8-12 Hz]



Theta
[4-8 Hz]



Delta
[1-4 Hz]



Time
1 sec



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-eeb-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 \sim 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-eeb-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 Reviews 29, 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 \sim 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-traumatic stress disorder and healthy subjects. *International Journal of Psychophysiology* 40, 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 Primary and Secondary Insomnia and Good Sleepers. *Control*.
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-eeb-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 Iglseider. 2017. EEG beta 2 power as surrogate marker for memory impairment: a pilot study. *International Psychogeriatrics* 29, 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 Iglseider. 2017. EEG beta 2 power as surrogate marker for memory impairment: a pilot study. *International Psychogeriatrics* 29, 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

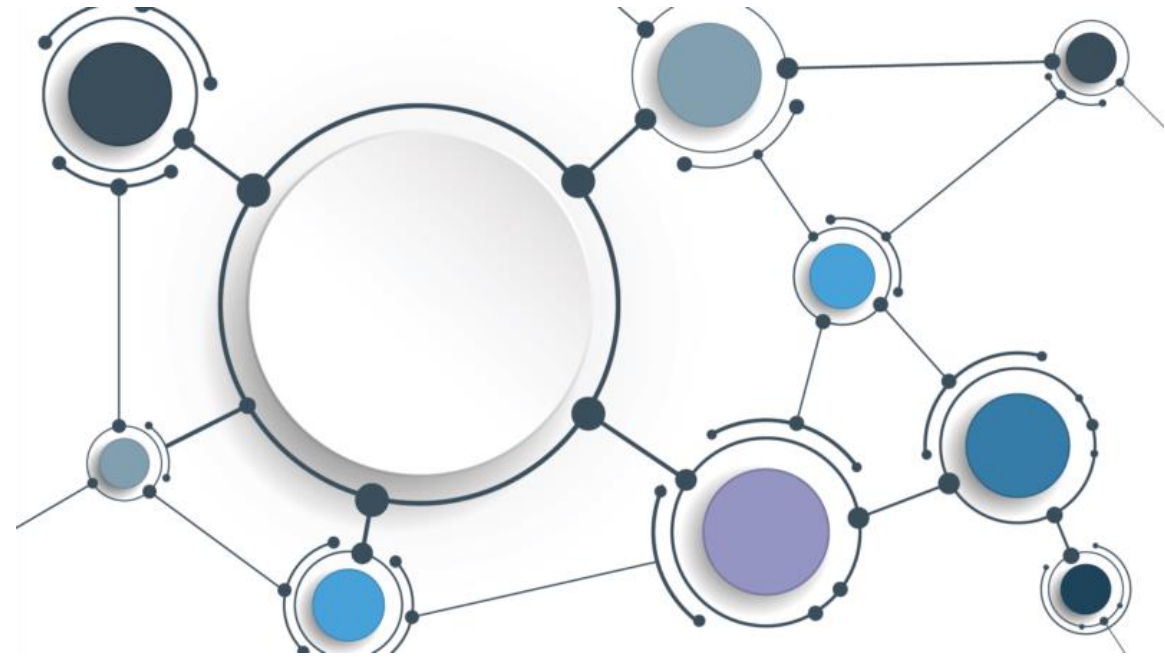
Why Contradiction?



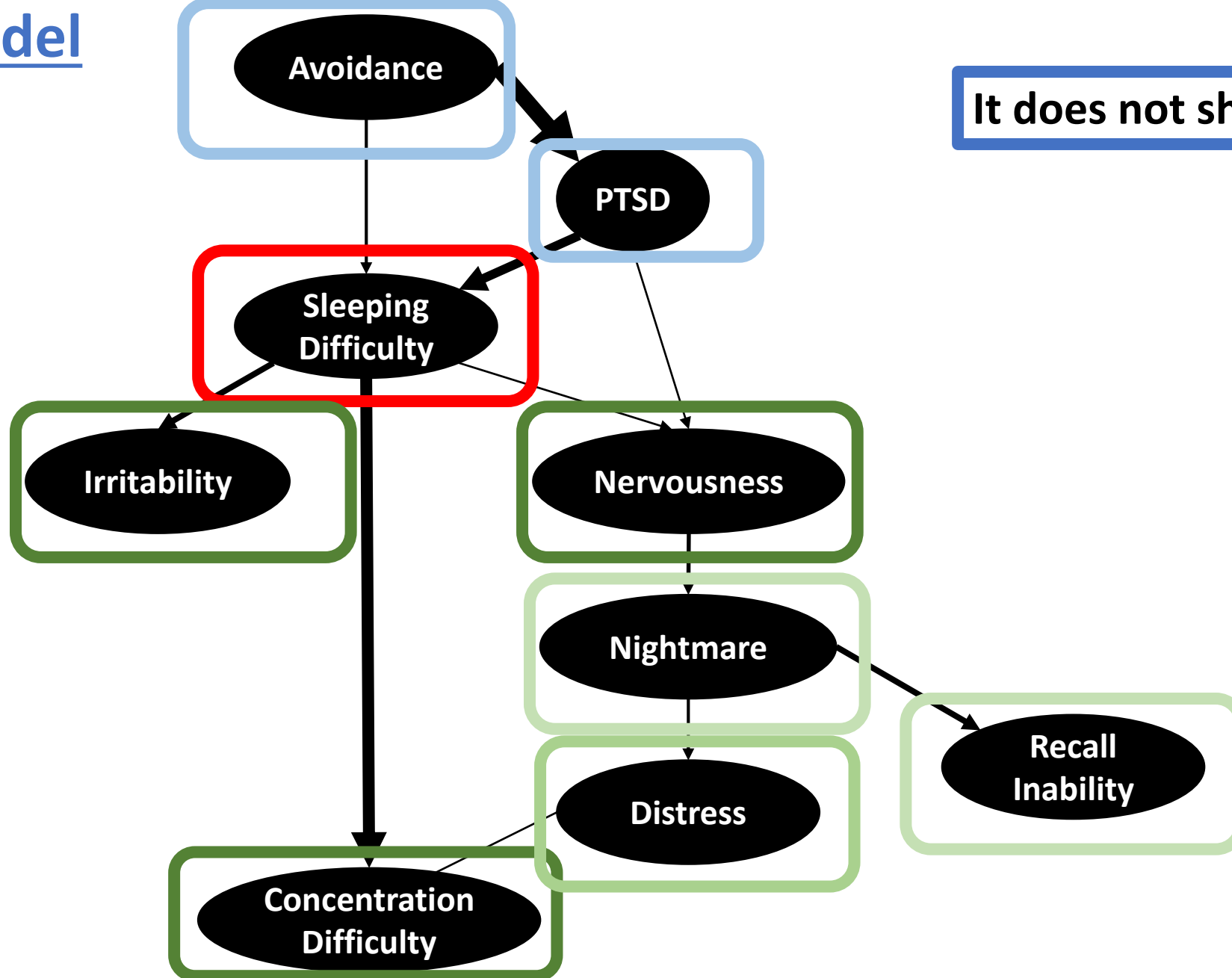
<https://www.utoronto.ca/news/new-technique-developed-u-t-uses-eeeg-show-how-our-brains-perceive-faces>



POST TRAUMATIC STRESS DISORDER



Bayesian Model



Take Home Message



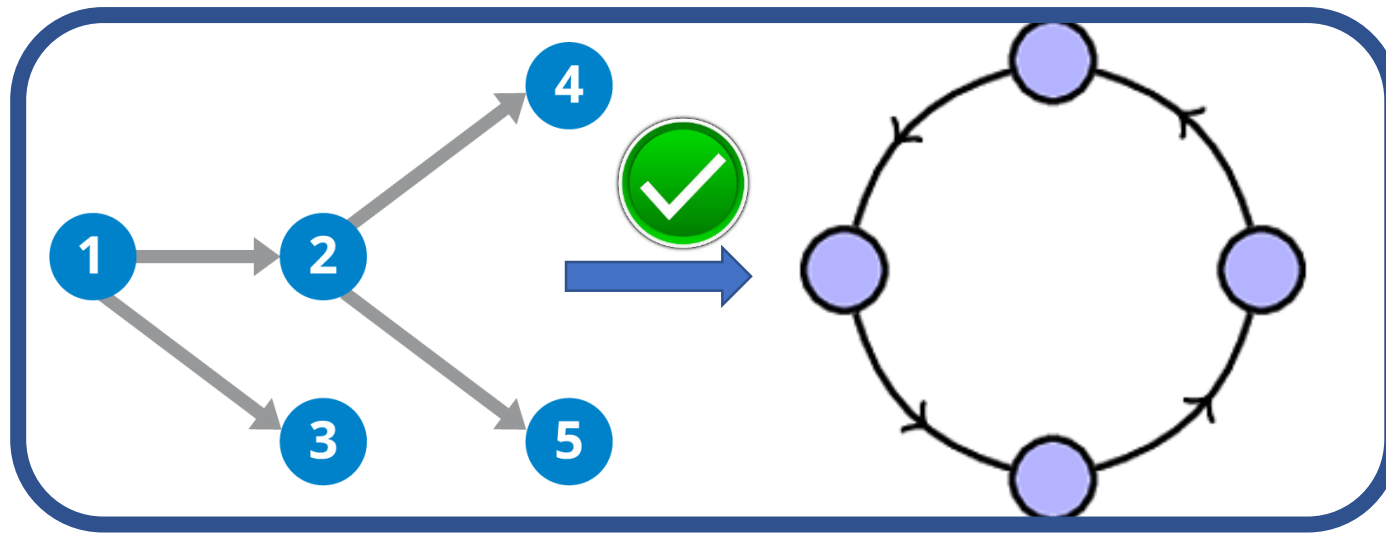
Koffel, Erin, Imran S. Khawaja, and Anne Germain. "Sleep disturbances in posttraumatic stress disorder: updated review and implications for treatment." *Psychiatric annals* 46.3 (2016): 173-176.

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.

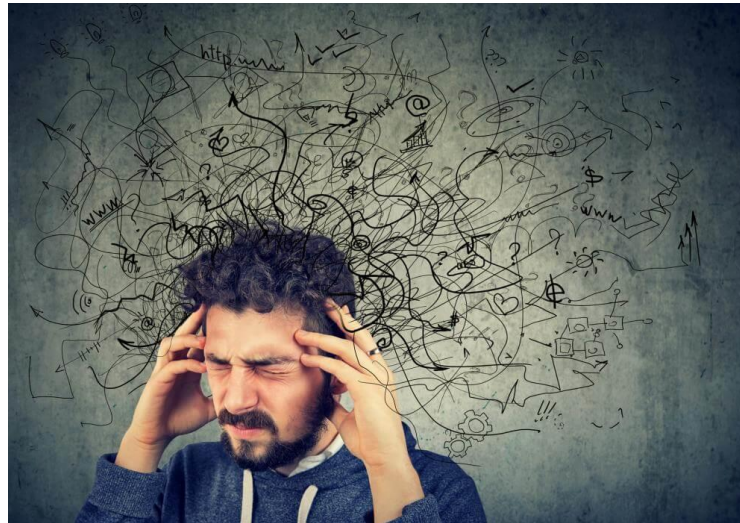


Future Works



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

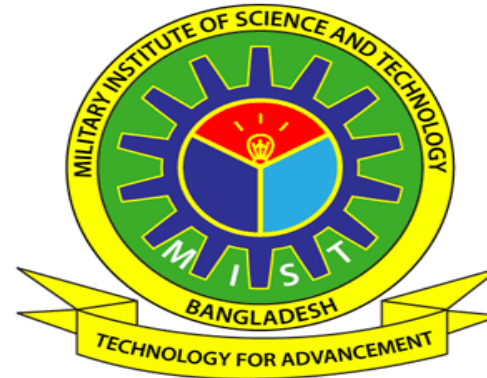
<https://uniontestprep.com/cna/blog/patient-differences-religious-ethnic-and-cultural>

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.

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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](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>