

Adventures in Building Emotion Intelligence Technologies

Rosalind W. Picard, Sc.D., FIEEE

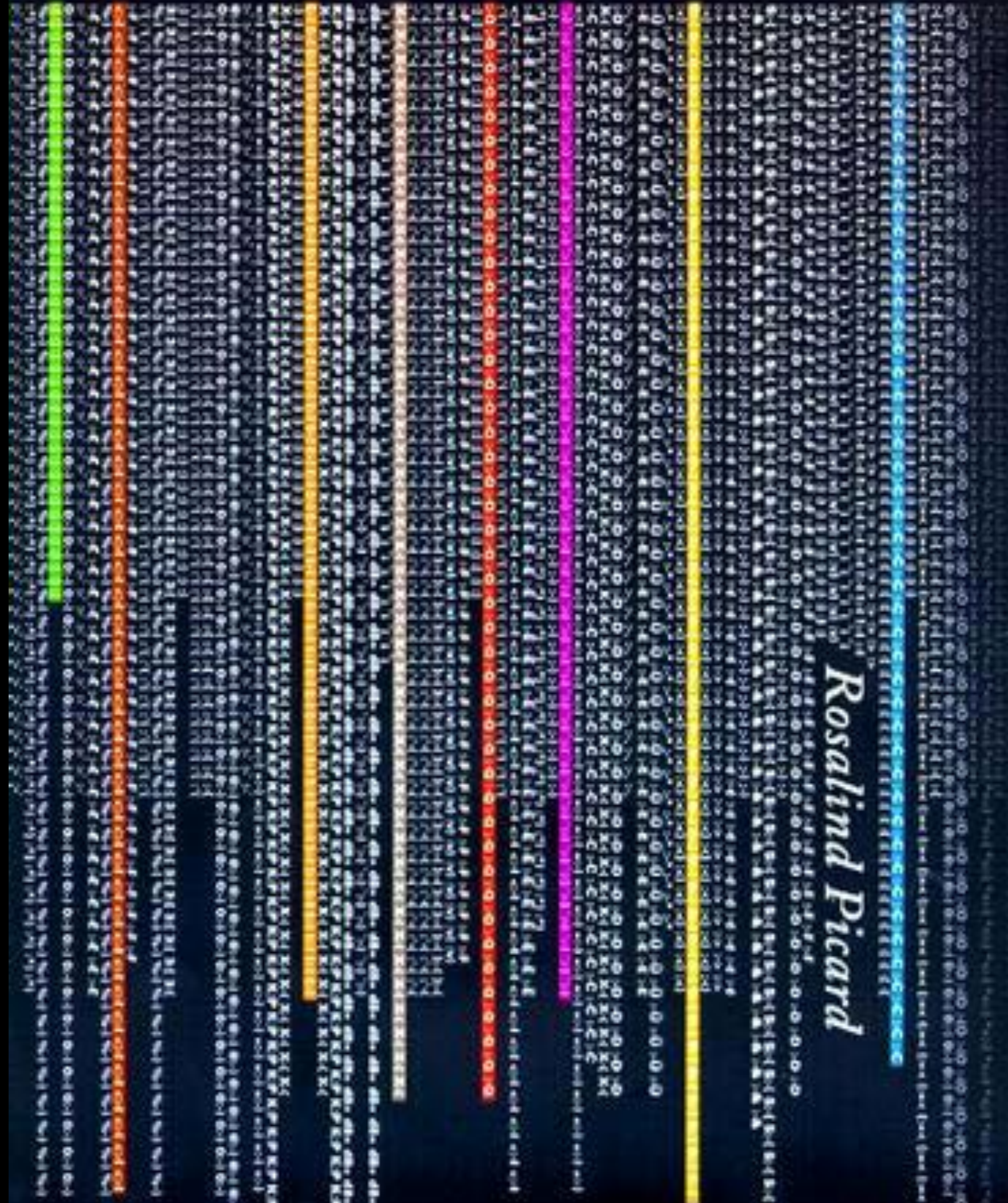
Professor, MIT Media Lab
Faculty Chair, MIT Mind+Hand+Heart
Co-founder and Chairman, **Empatica, Inc.**
Co-founder, **Affectiva Inc.**



Media Lab Affective Computing



AFFECTIVE COMPUTING



Affective computing is computing that relates to, arises from, or deliberately influences emotion

Intelligent interaction?

Intelligent interaction?



Intelligent interaction?



Intelligent interaction?



These should stop
looking happy



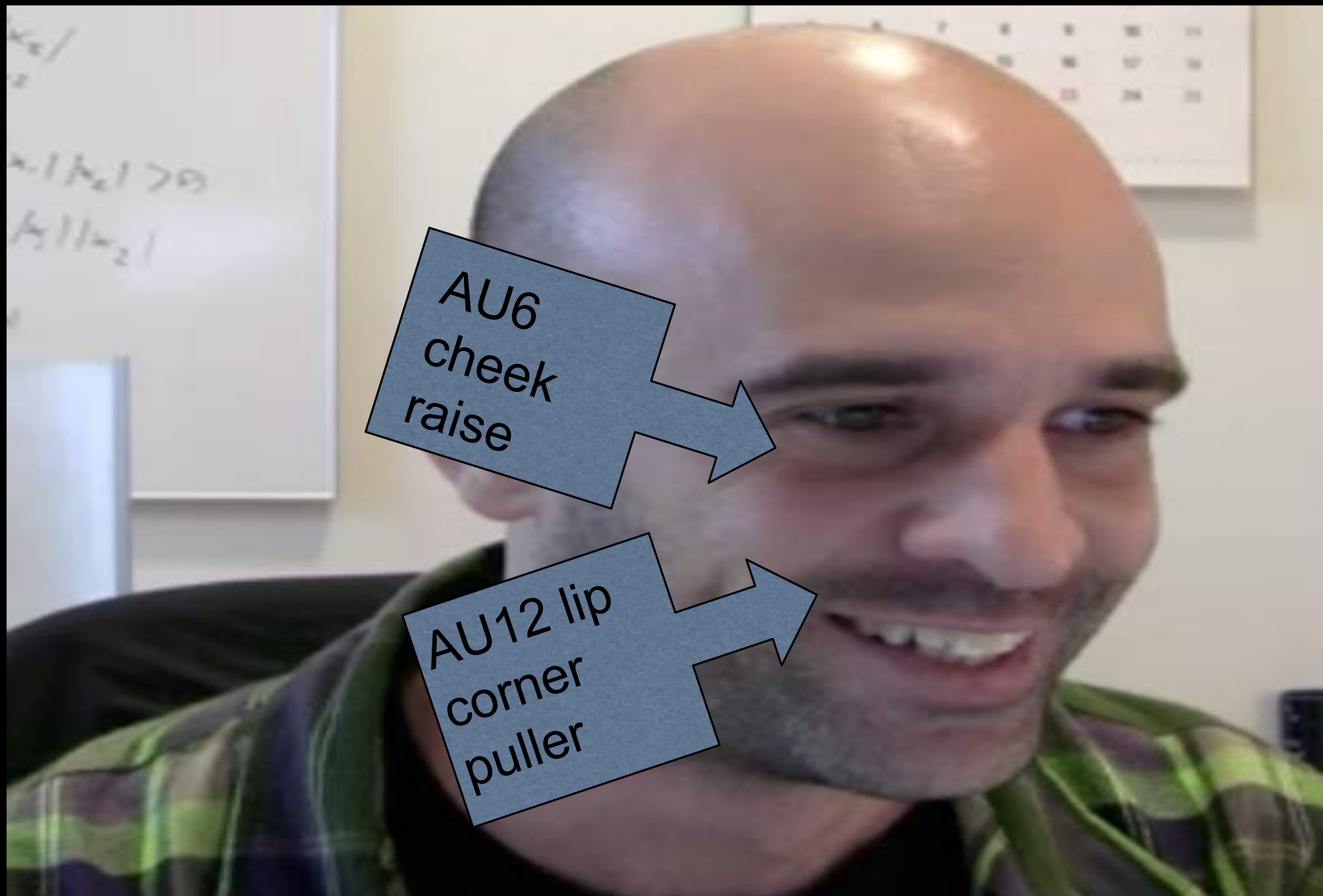
Intelligent interaction?



These should stop
looking happy



``Singing cheerful songs to a person with a heavy heart is like taking someone's coat in cold weather or pouring vinegar in a wound. Proverbs 25:20 *New Living Translation*

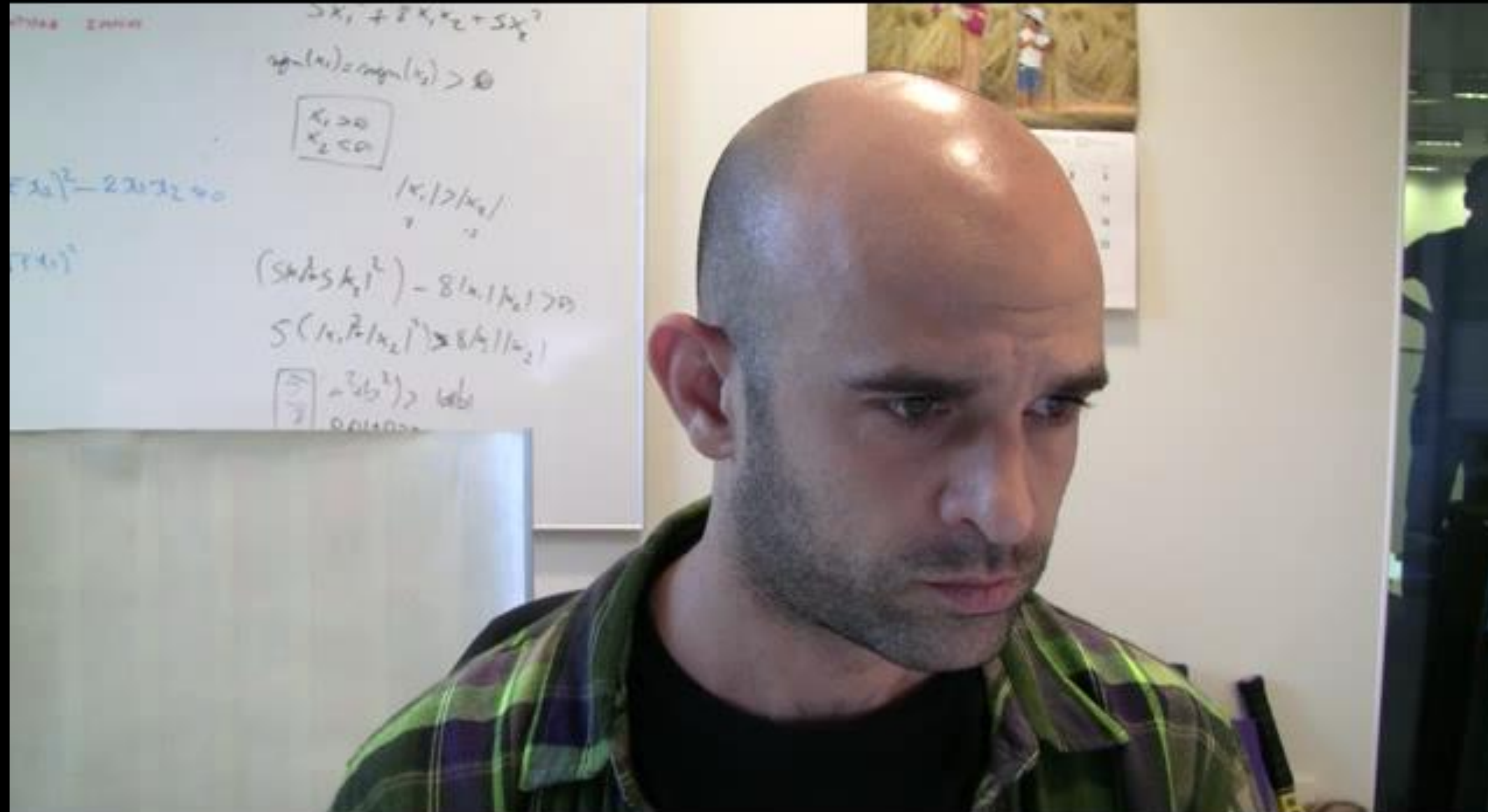




We didn't tell him
we used
"impossible"
captchas

pliarom

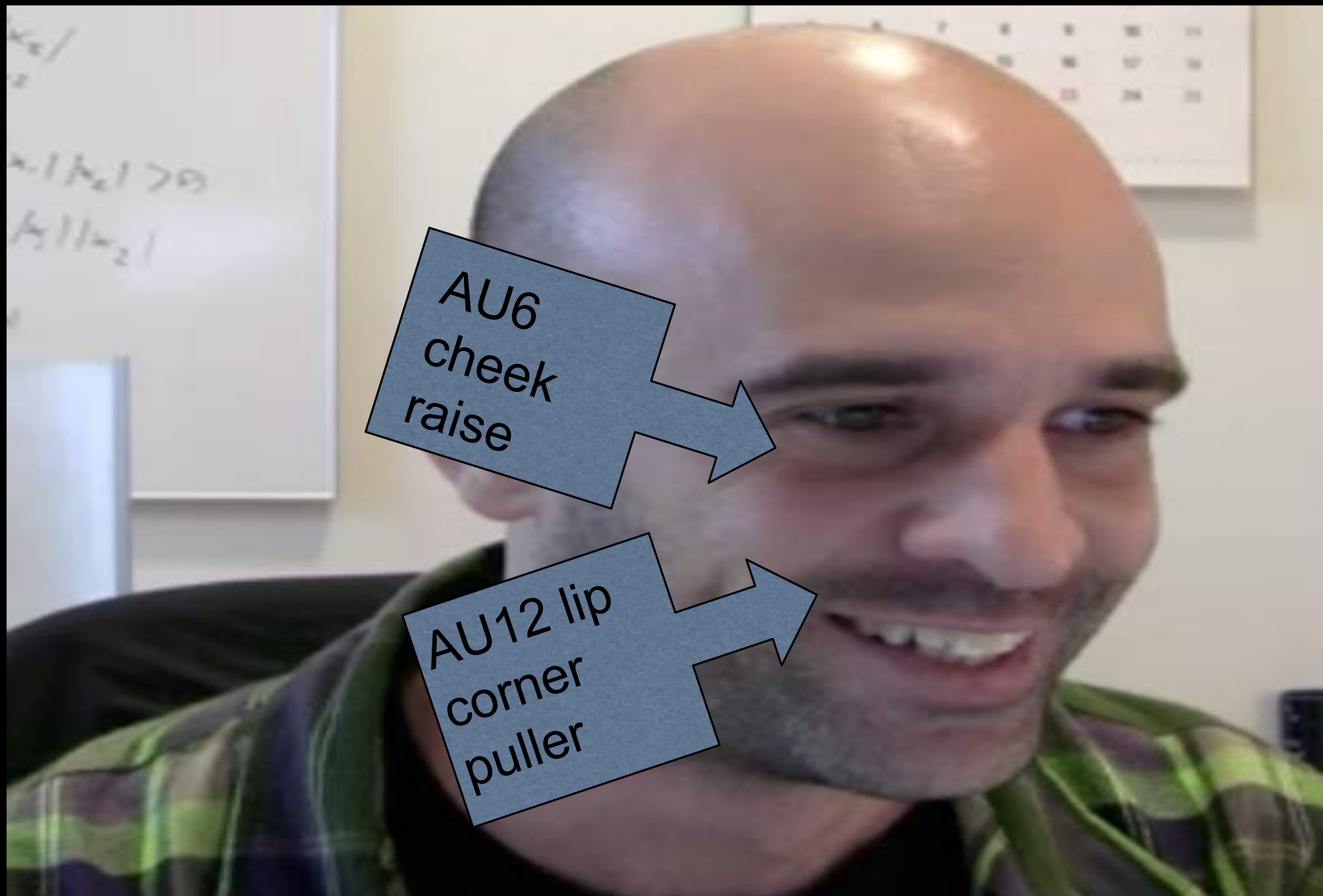
sorted



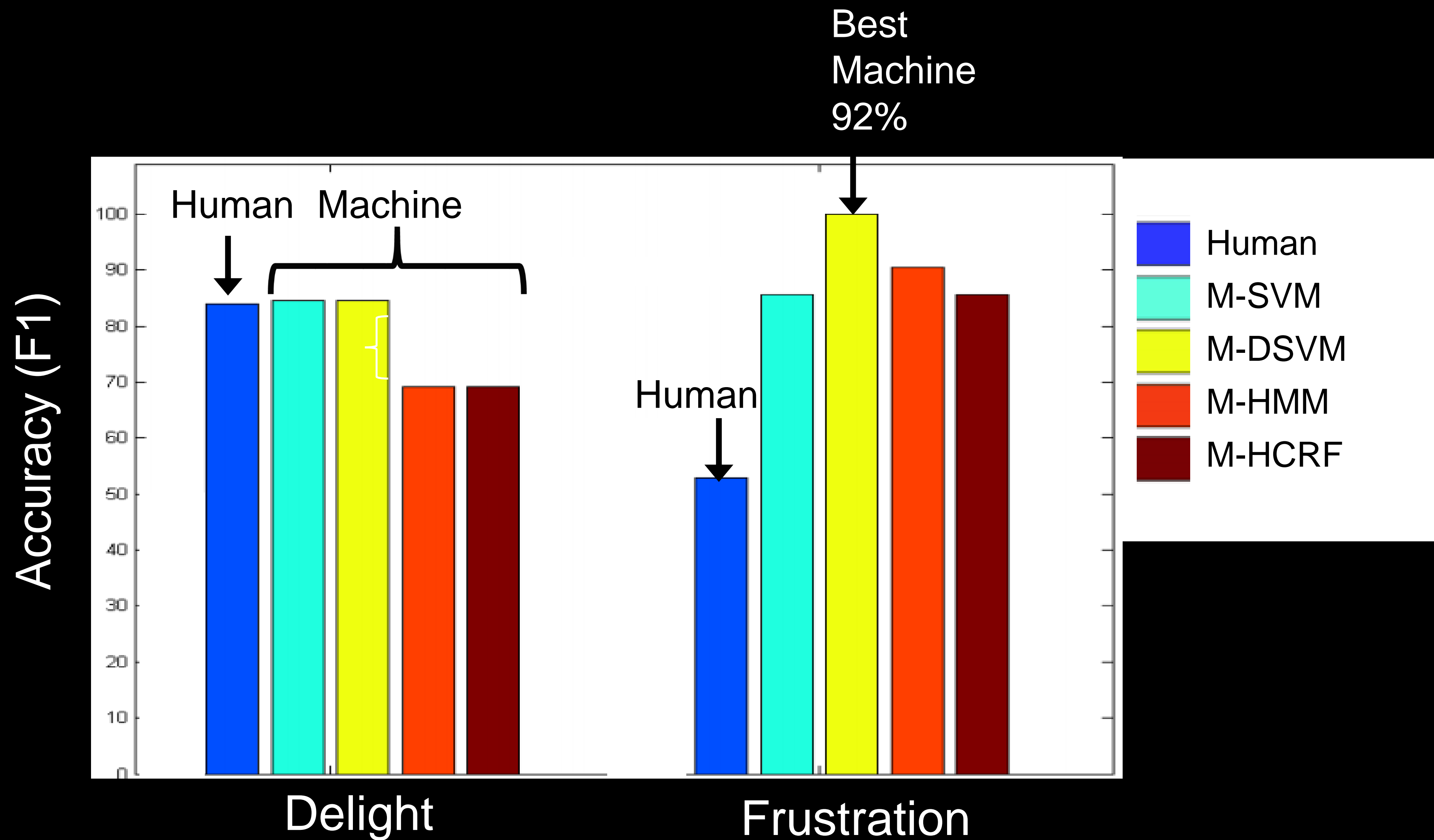
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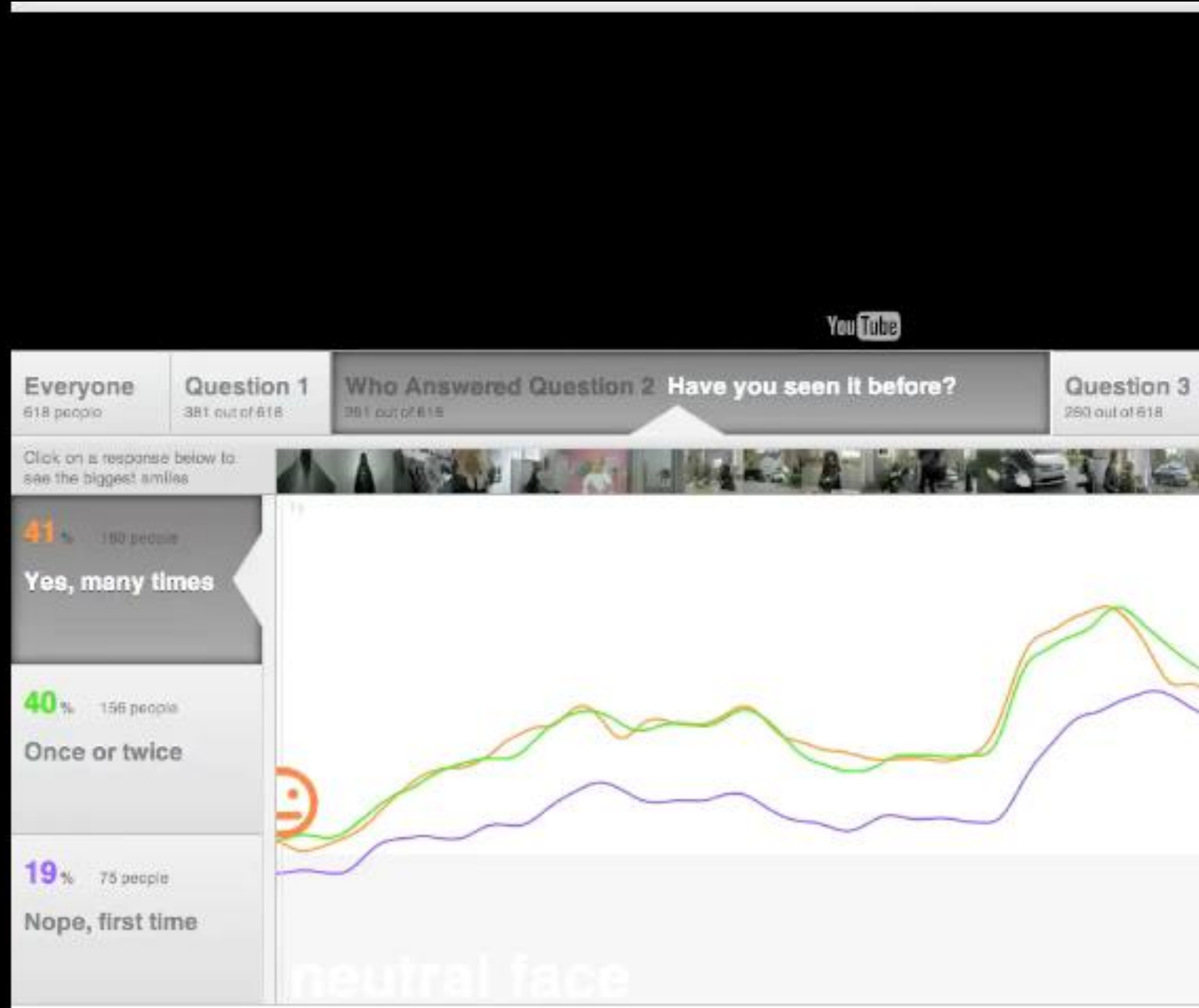
90% of people showed this smile during **frustration**



Machine learning to classify delight vs. frustration smiles

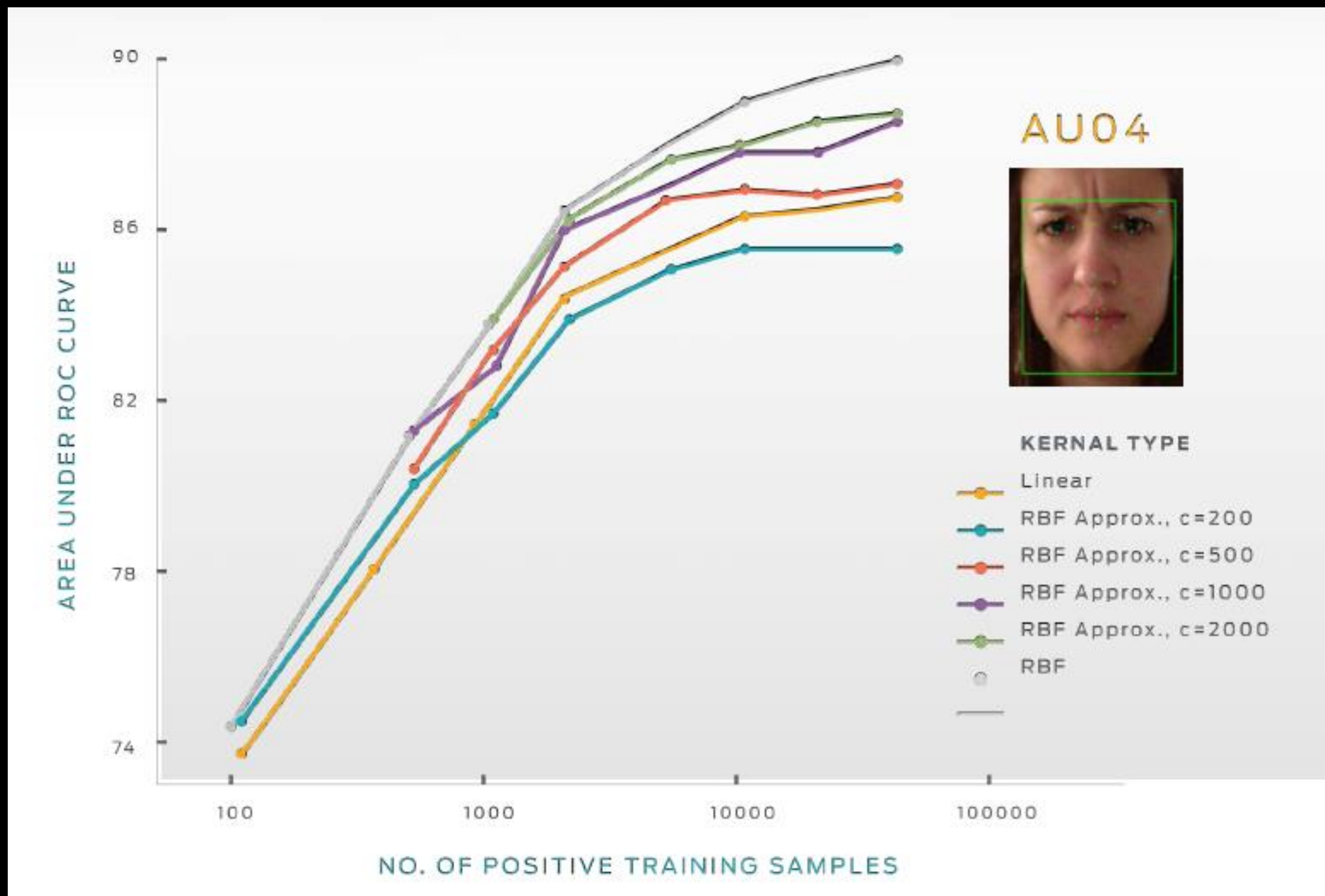
Hoque, McDuff, Picard (2012) IEEE Trans. Affective Computing

Opt in online with your webcam



McDuff, el Kaliouby, Picard, "Crowdsourcing Facial Responses to Online Videos," *IEEE Transactions on Affective Computing*, 2012.

Deployment actually improved the science!



Dan McDuff, MIT PhD 2014
Crowdsourcing facial affect and prediction analytics:

- *Won best student paper award Face & Gesture*
- *The only paper at ESOMAR nominated for all three prizes:*

“Best methodology paper”
“Best case history”
“Best overall paper”

Interactive real-time facial emotion recognition



- 90% accurate on 24 expressions
- 75 countries
- 50 B emotion data points measured
- 1400 brands
- Used by 1/3 of Fortune Global 100
- HCI, Gaming, Robots, Medical

Demo App

AffdexMe

FREE at:

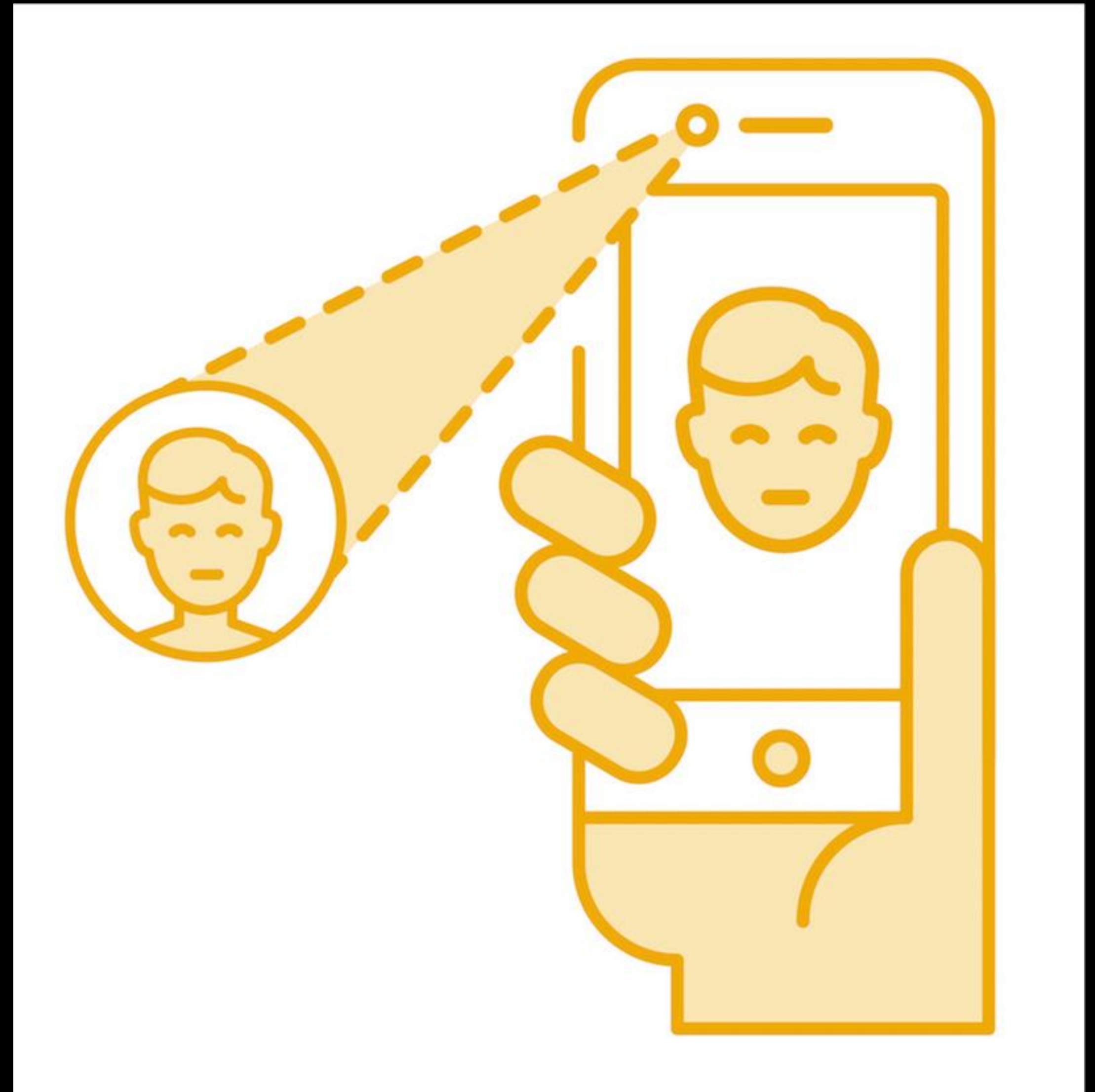


Real-Time Emotion SDK

Makes it easy to add facial emotion sensing to adapt to human emotion in real time.



For gaming, robotics, automotive, retail, advertising, education, healthcare and mobile devices.



Get affectiva.com/sdk FREE!



Electrodermal Activity (EDA) Sensors

(old terminology: “galvanic skin response”)



Traditional: Biopac,
Thought Technology

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MIT Media Lab
Innovations

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MIT Media Lab
Innovations



Empatica
Embrace and E4

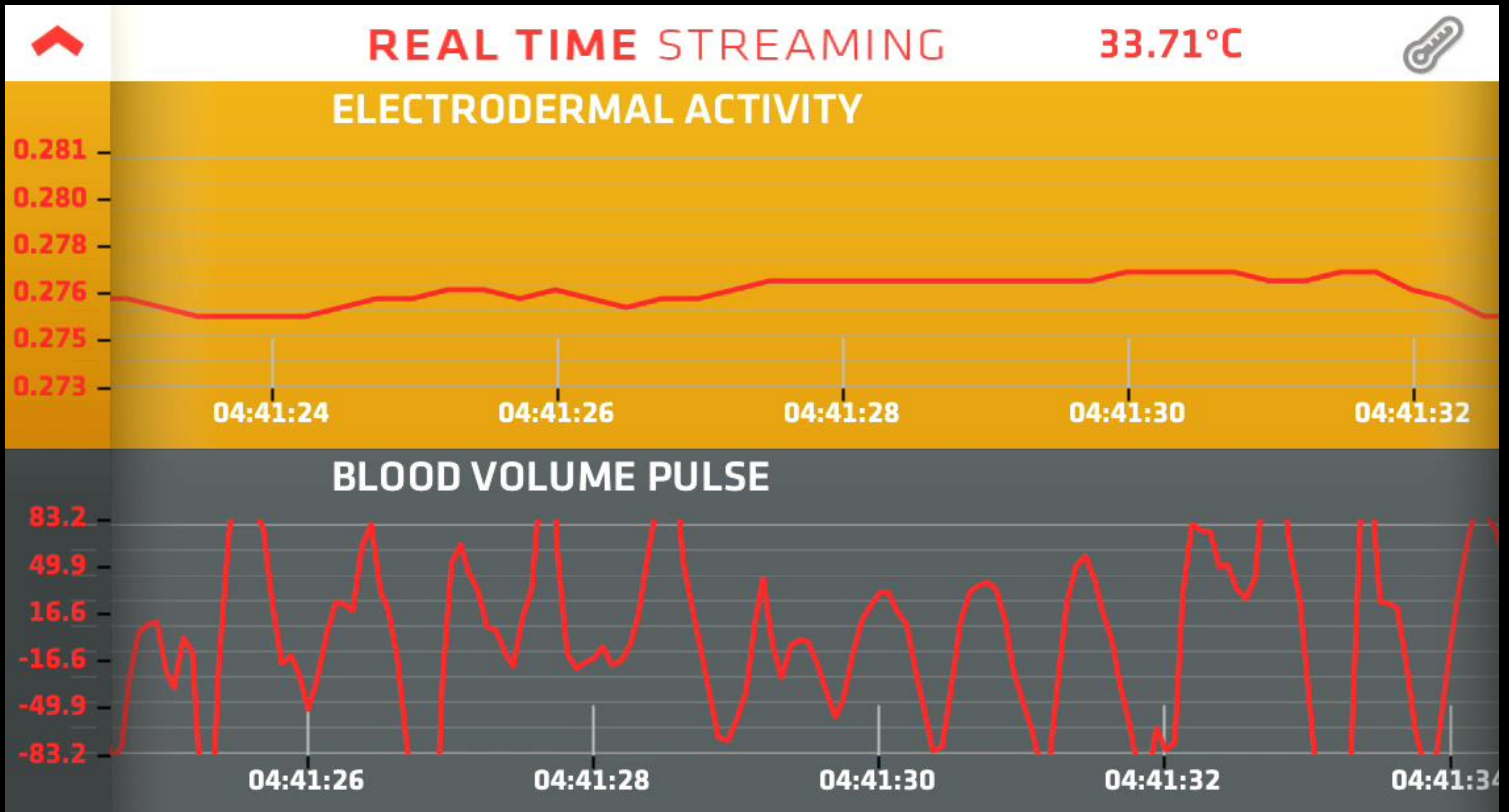


E4 for research:

- Physical activity
- Temperature
- 2-color PPG (BVP)
- Skin conductance

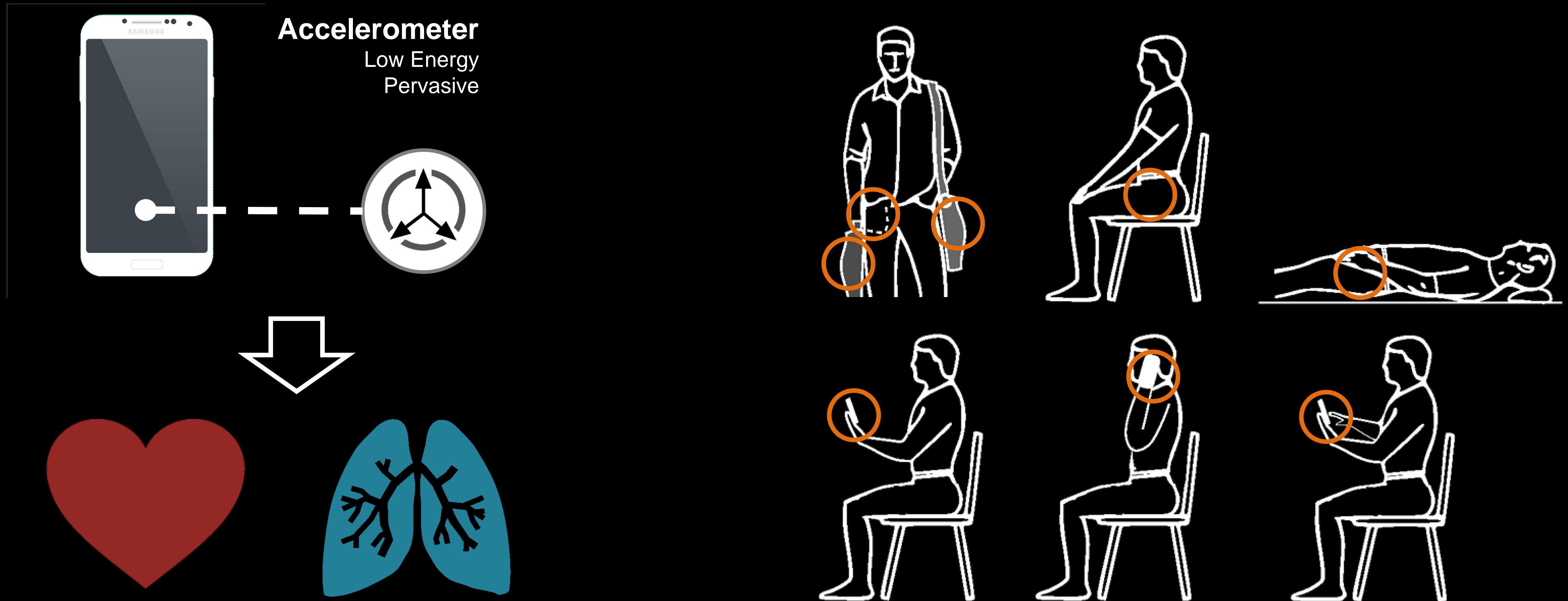
**Autonomic stress:
Sympathetic &
Parasympathetic**



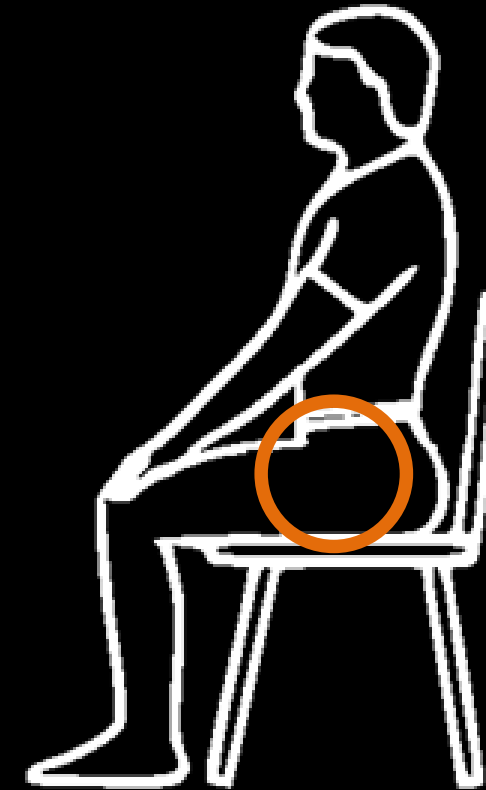


Empatica E4 sensor data

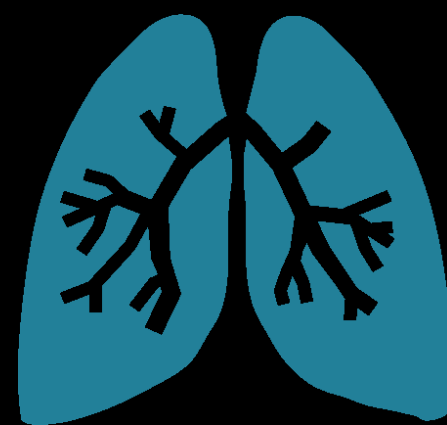
Your phone records YOUR subtle motions even when you're "NOT MOVING"



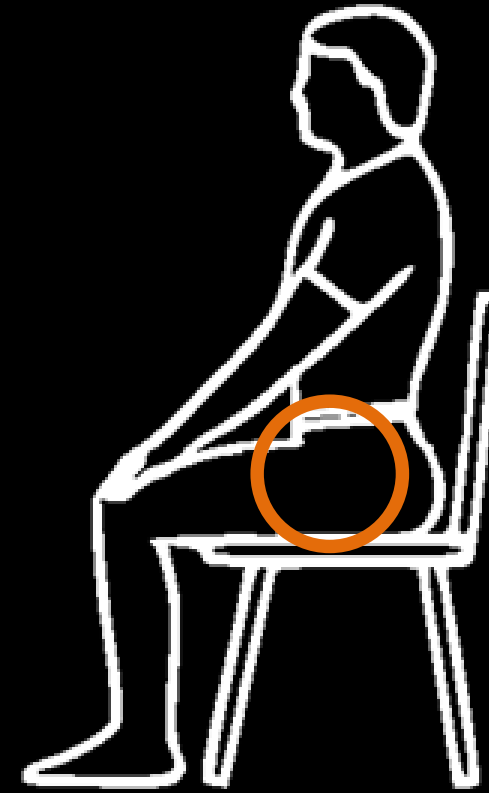
Physiology Monitoring from Peripheral Smartphone Motions



Avg Error



Physiology Monitoring from Peripheral Smartphone Motions

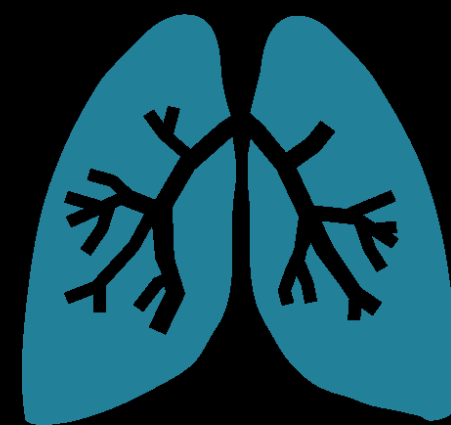


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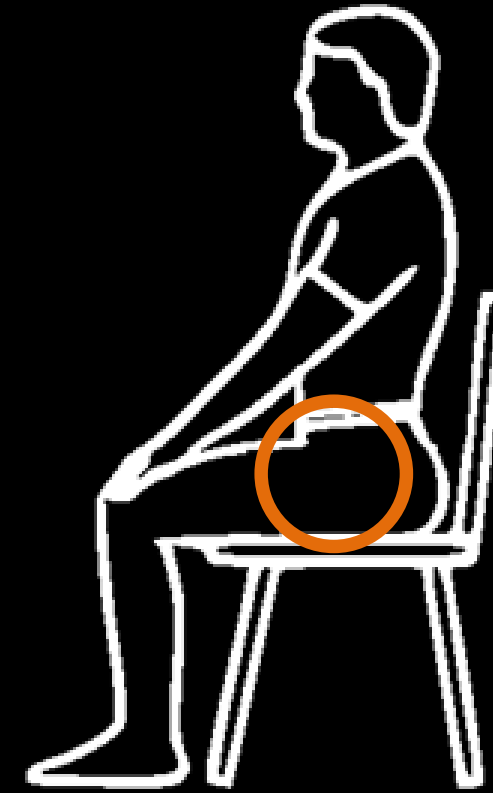


1.16

Beats/min



Physiology Monitoring from Peripheral Smartphone Motions

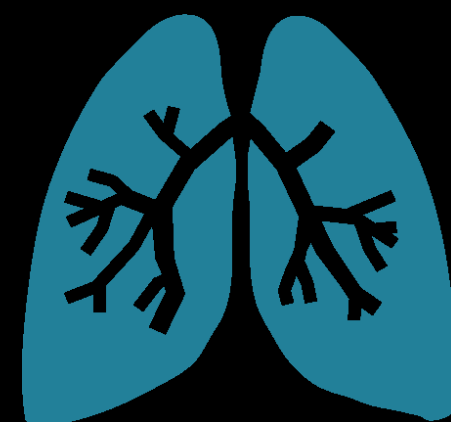


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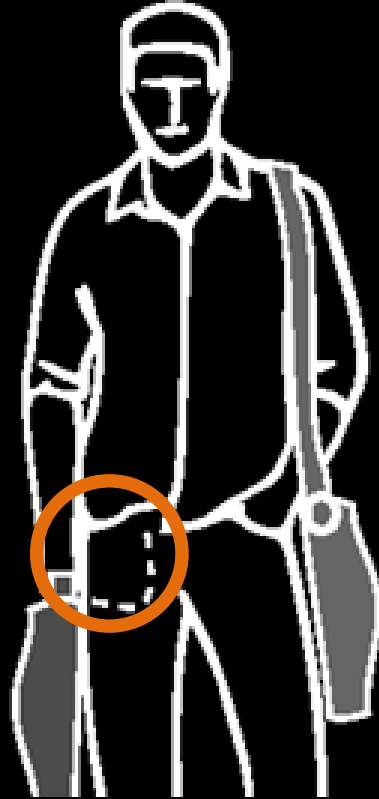
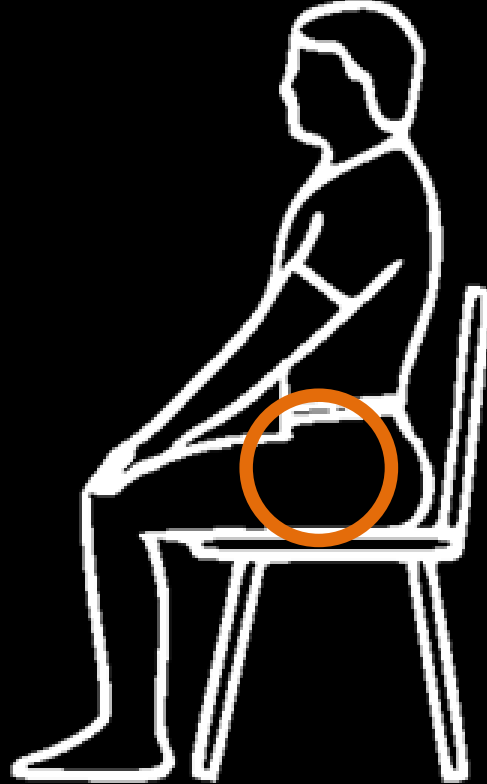


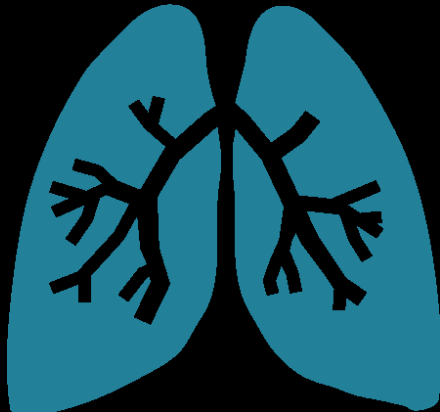


0.26

Breaths/min



Physiology Monitoring from Peripheral Smartphone Motions

				Avg Error
	3.37	1.97	1.16	Beats/min
	2.16	0.26	0.92	Breaths/min

Physiology Monitoring from Peripheral Smartphone Motions

				Avg Error
	3.37	7.90	2.38	Beats/min
	2.16	2.26	2.05	Breaths/min

Heart rate and breathing rate from smartphone motions



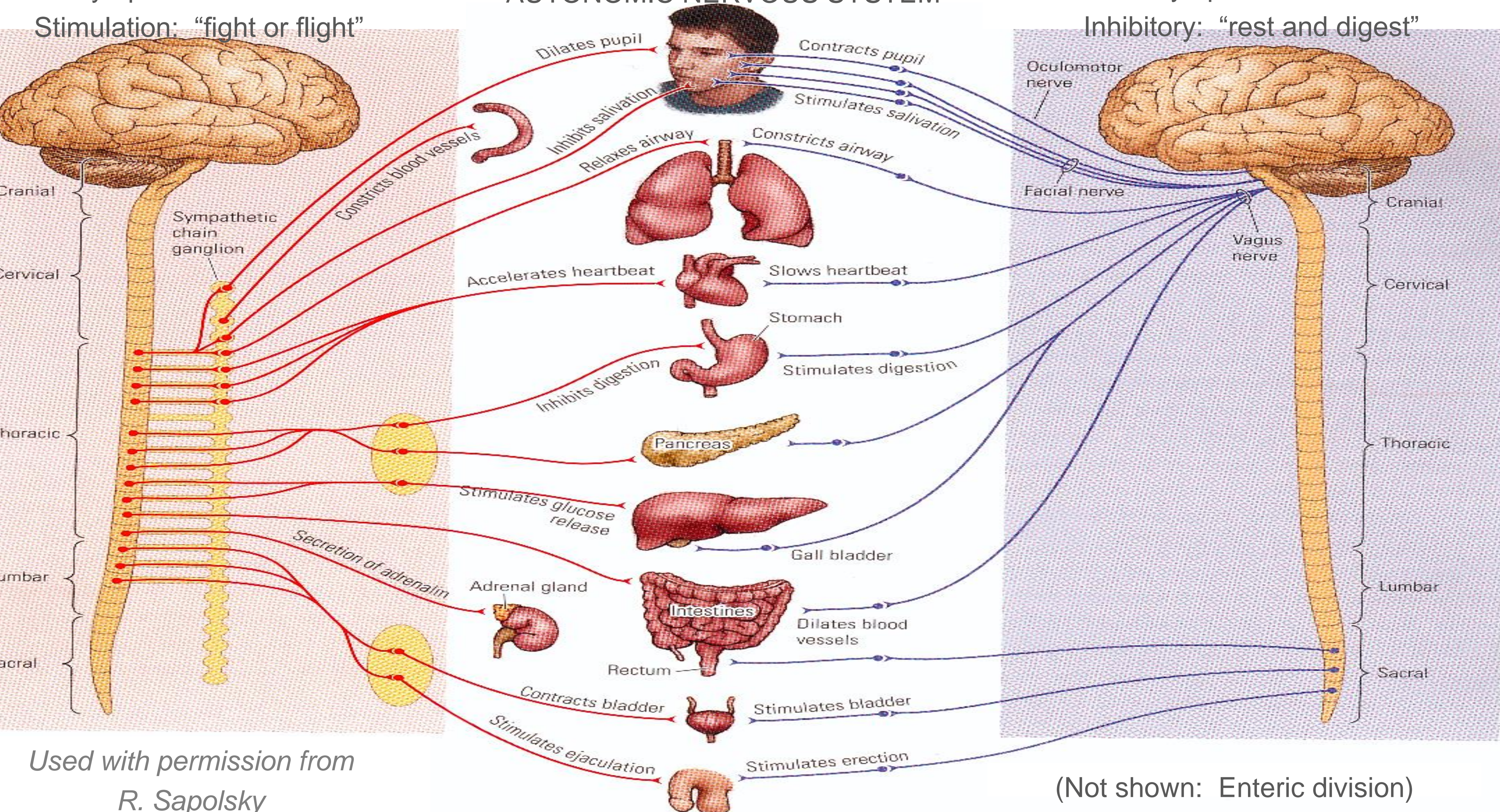
AUTONOMIC NERVOUS SYSTEM

Sympathetic division

Stimulation: "fight or flight"

Parasympathetic division

Inhibitory: "rest and digest"

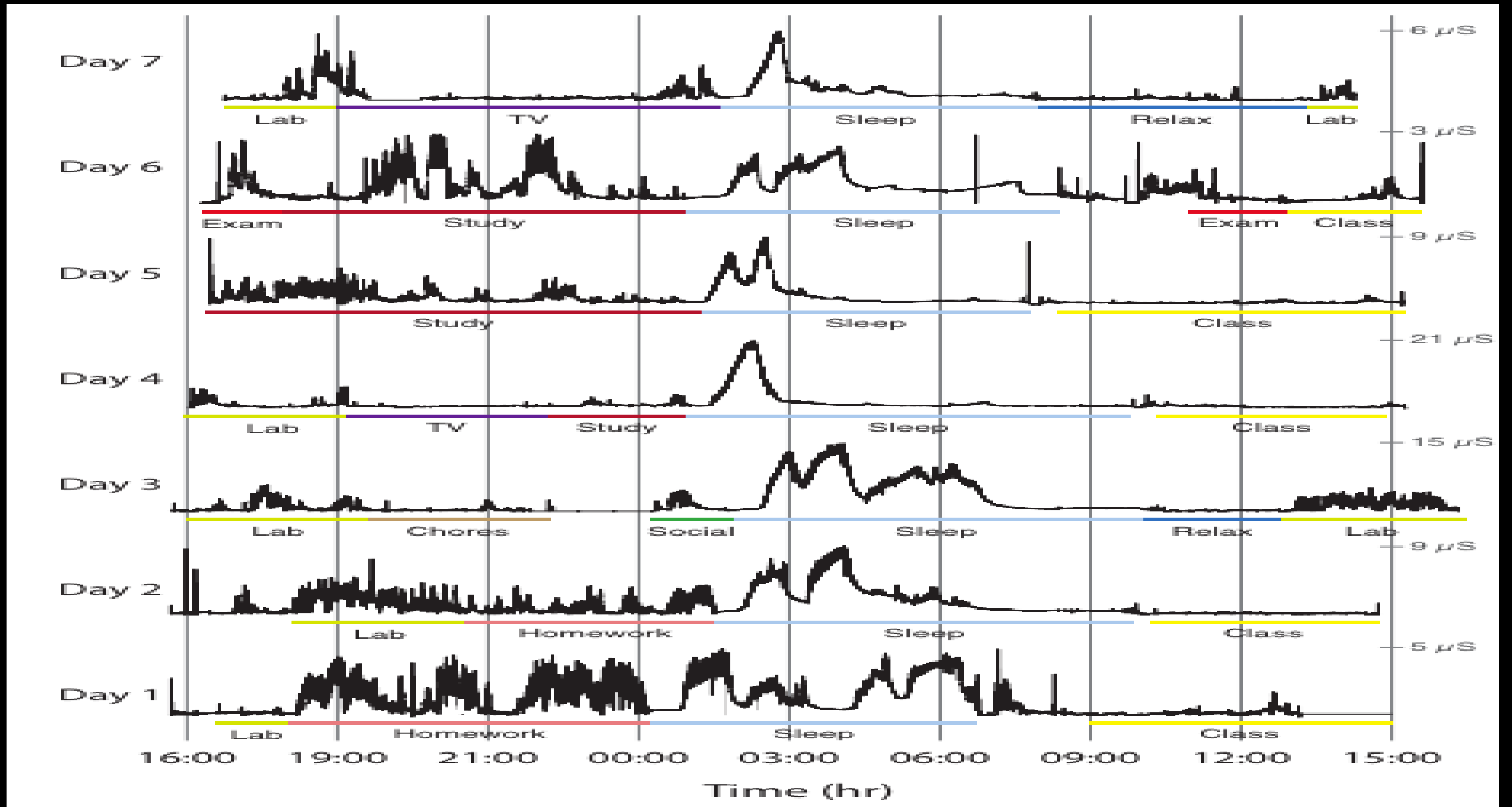


Used with permission from
R. Sapolsky

(Not shown: Enteric division)

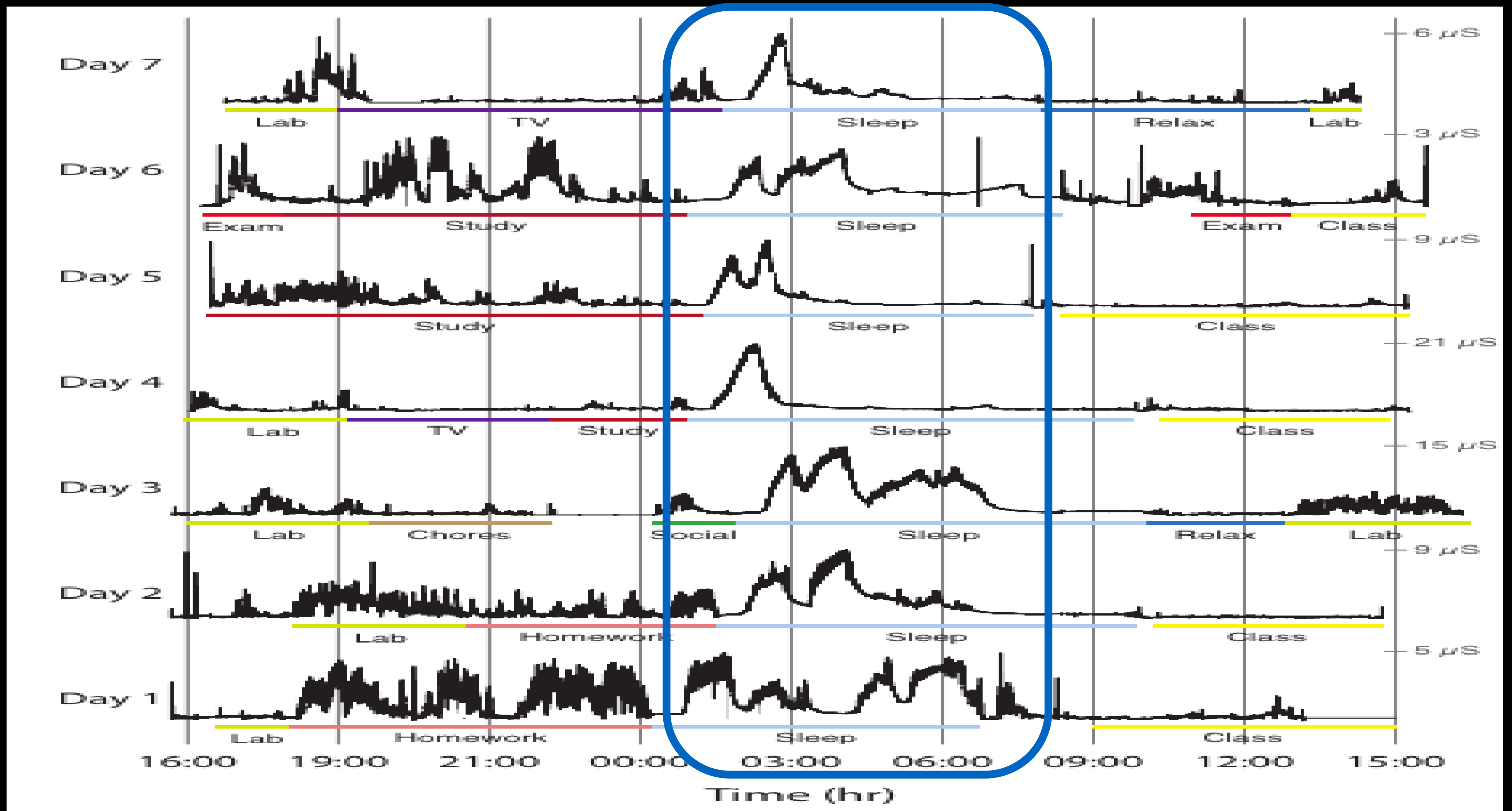
MIT Student, 7 days, 24 hours/day

Electrodermal Activity, μS



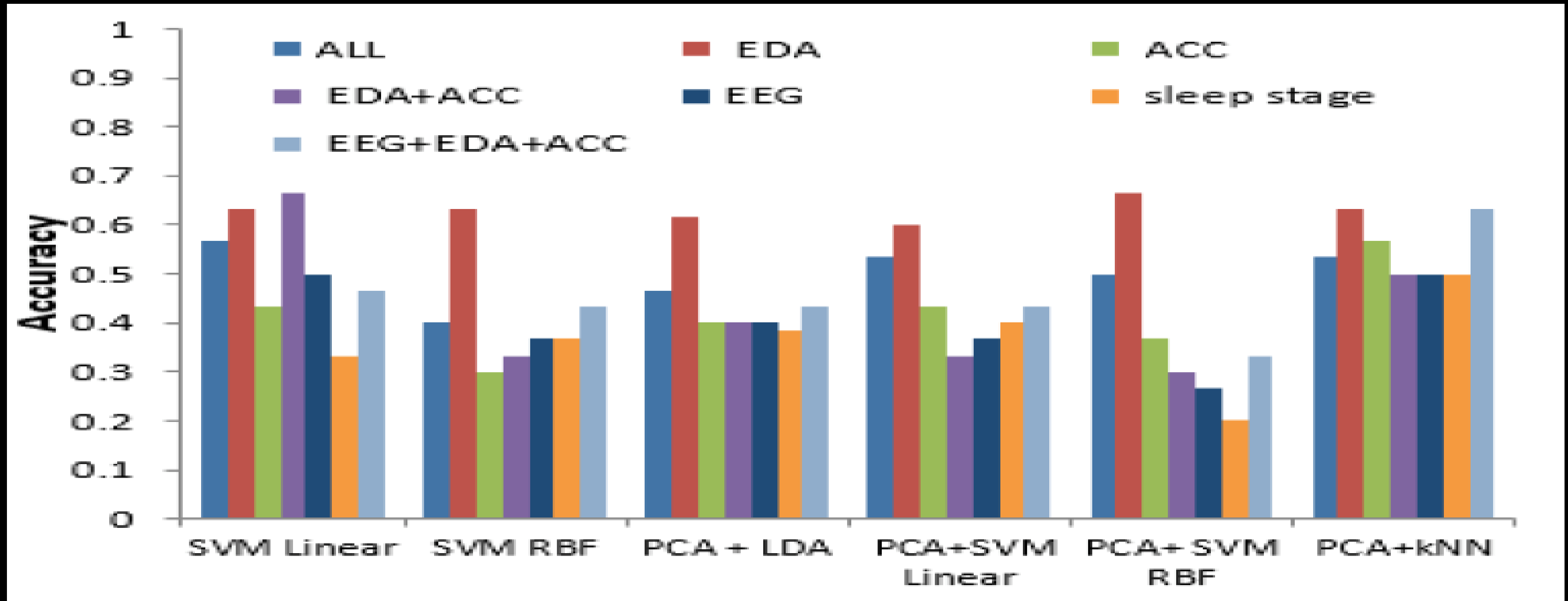
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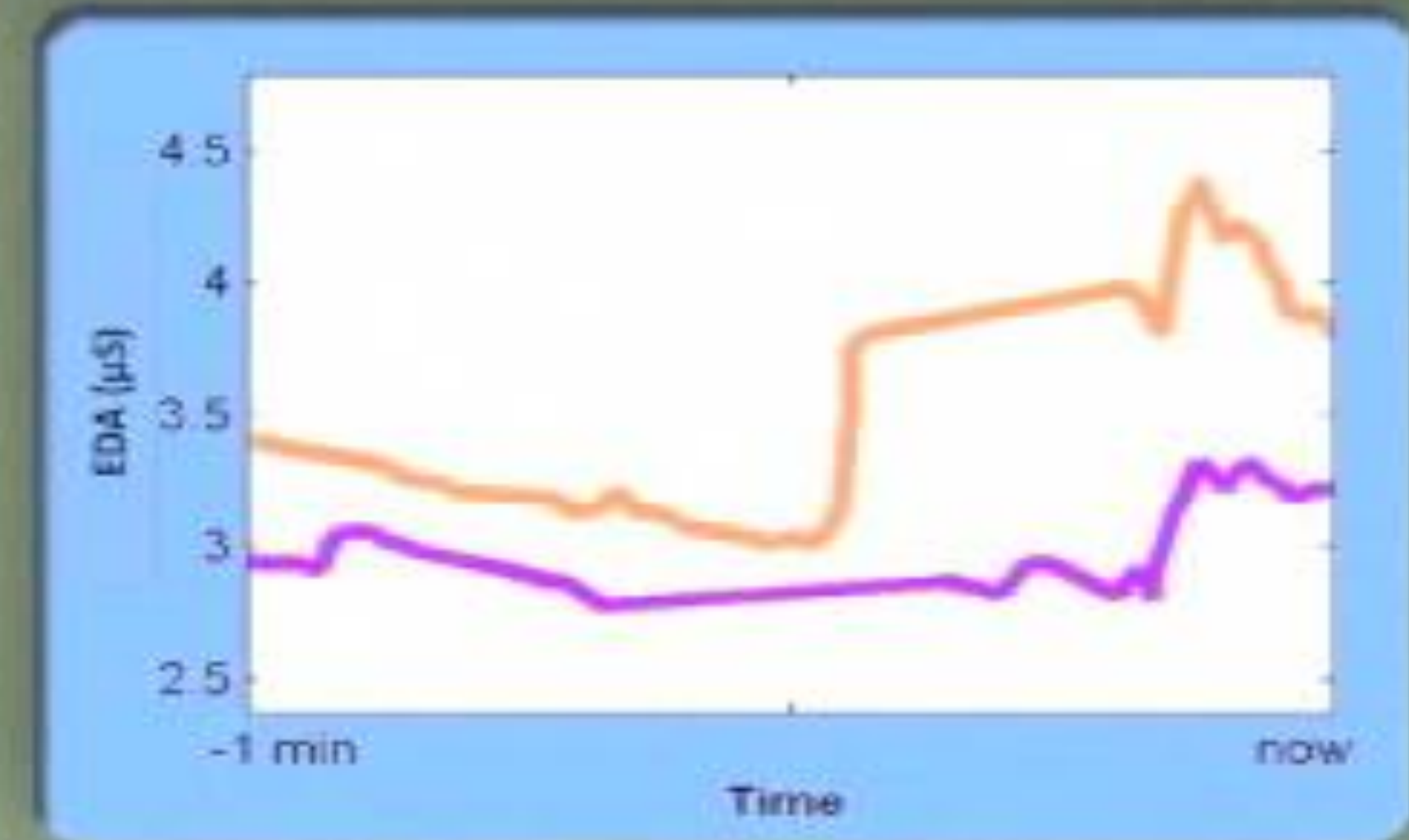


Largest peaks of “arousal” are usually during Non-REM sleep

Discriminating high/low learning after sleep: EDA (wrist) is more accurate than EEG (scalp).

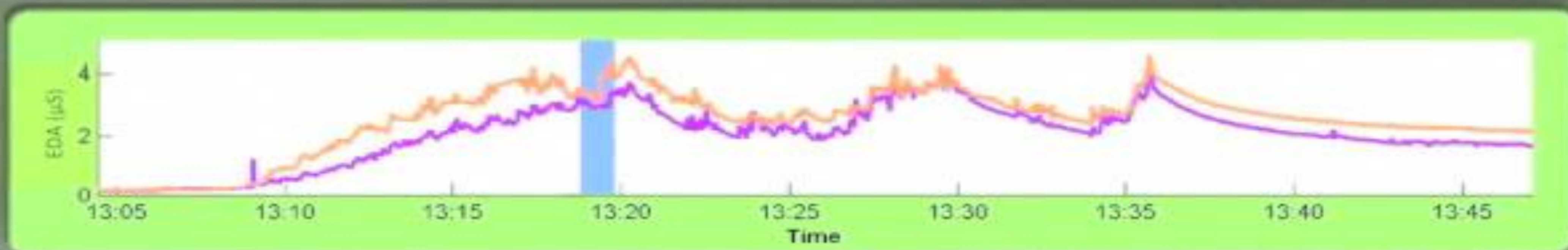


N=24 healthy adults, 72 nights of sleep. Classifying highest vs. lowest 20% of VDT Performance, Sano & Picard, Body Sensor Networks, Cambridge MA 2013



Live

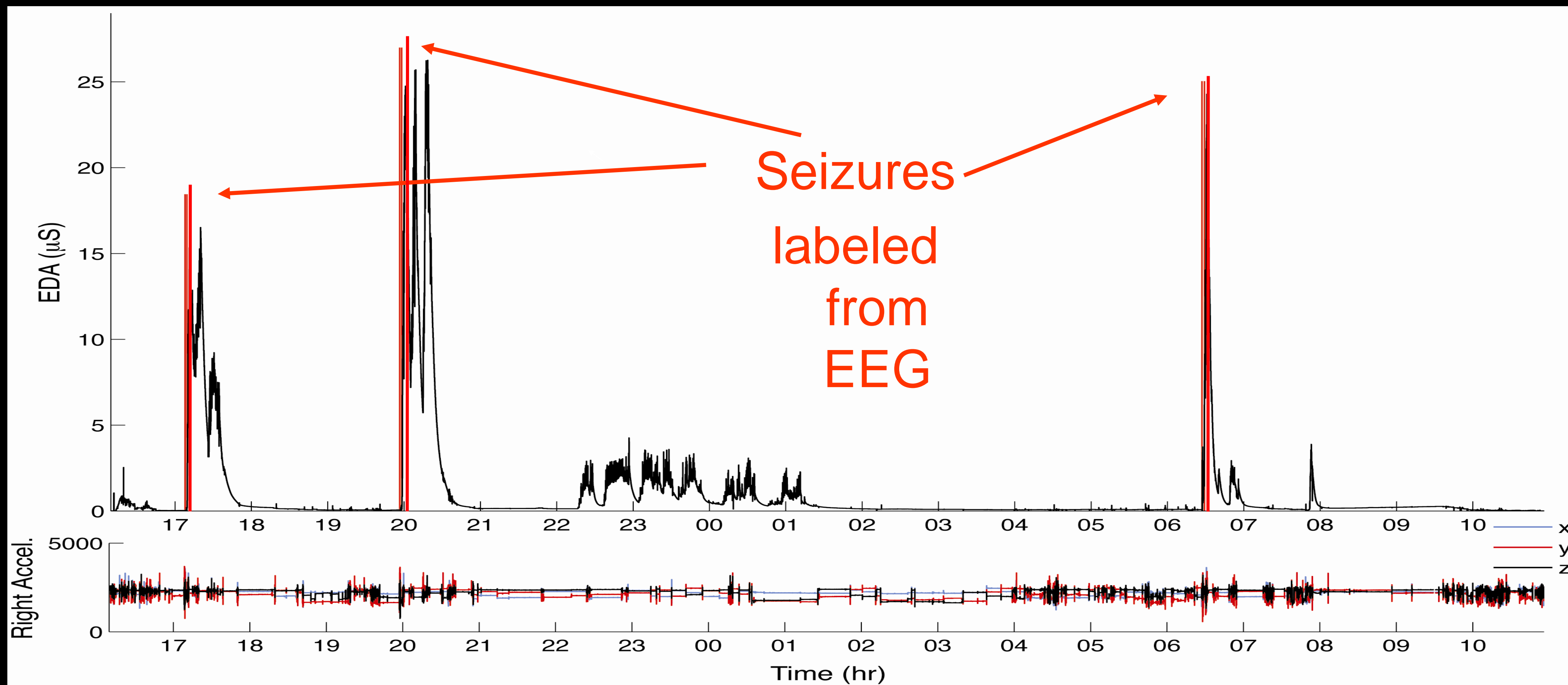
Full Session



Measuring electrodermal activity (EDA): Peak = meltdown

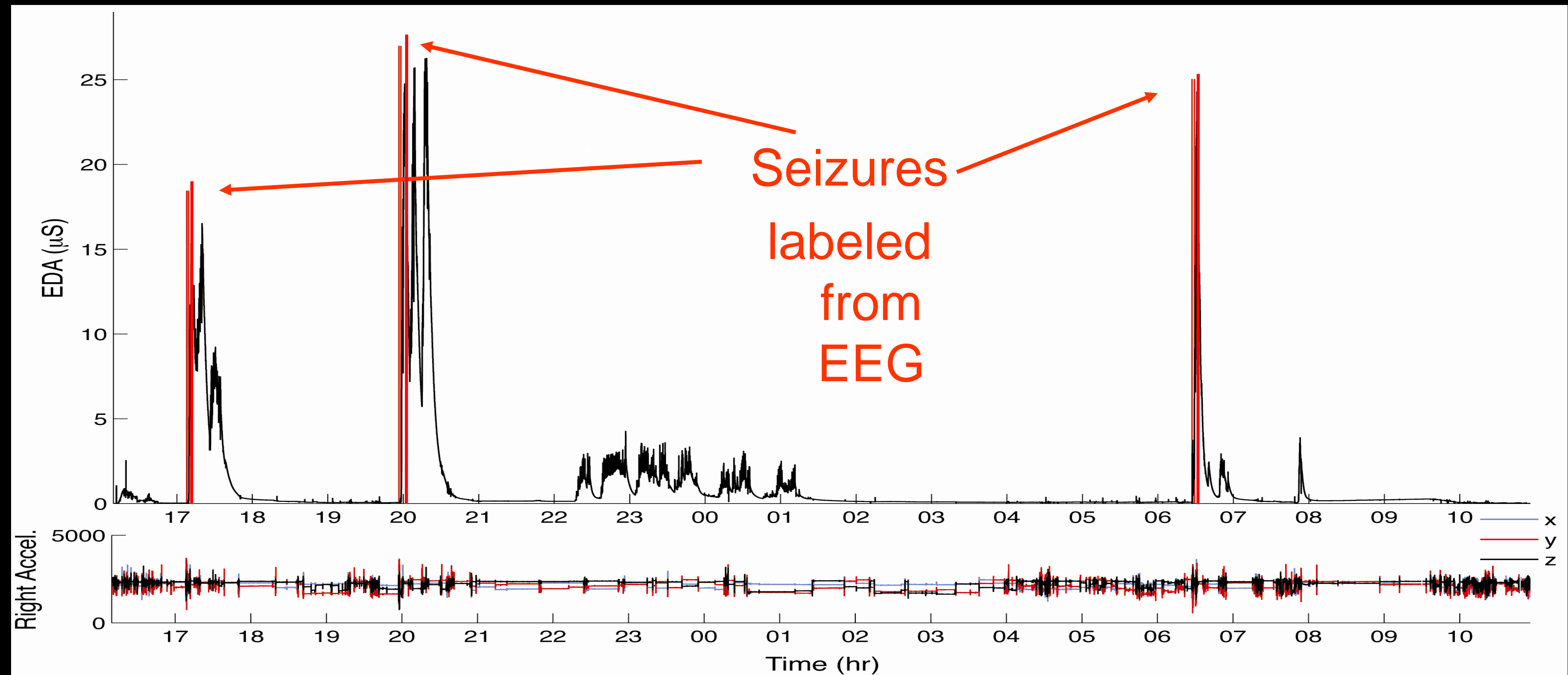
“Can I borrow a sensor to see what is causing stress for my little brother?”

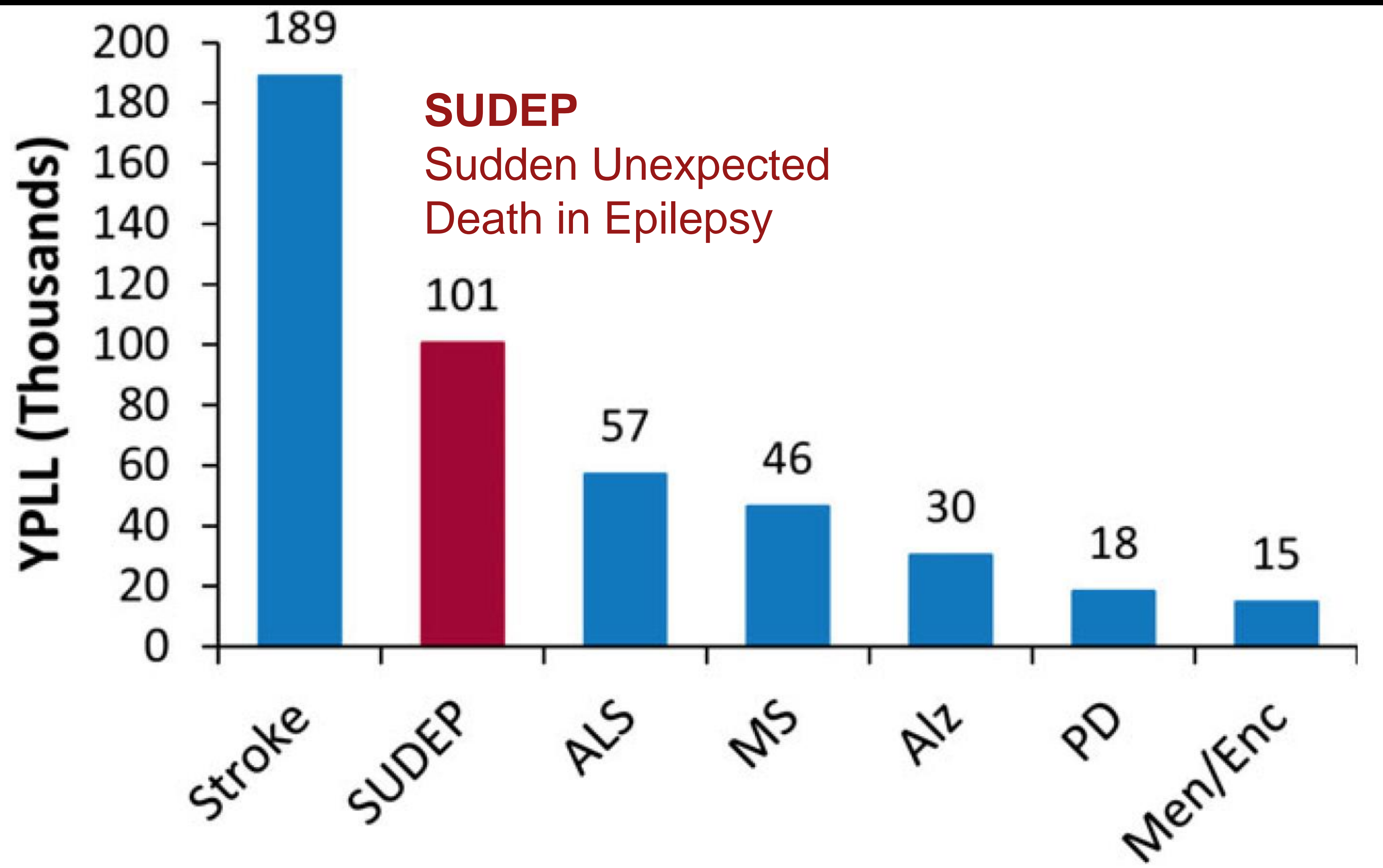




94% accurate convulsive seizure detection using a wrist-worn
electrodermal activity and accelerometry biosensor.

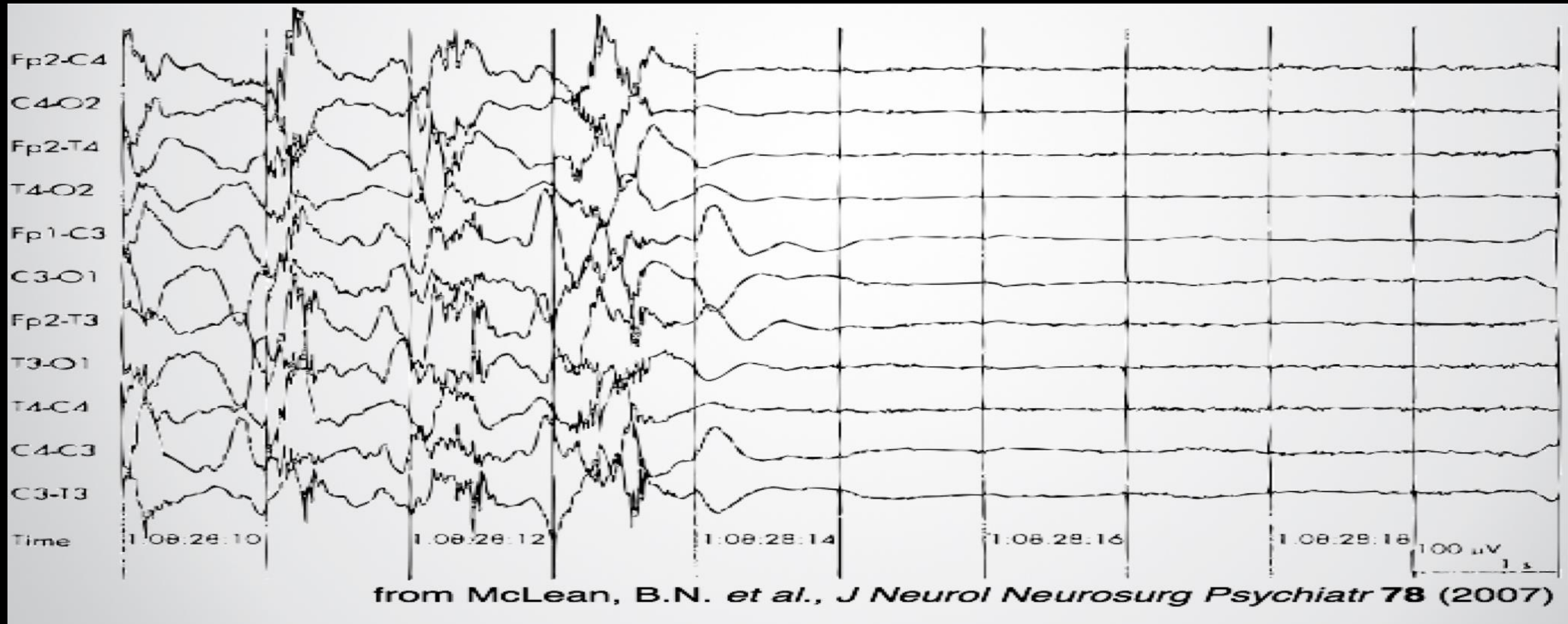
Poh et al (2012), *Epilepsia*.



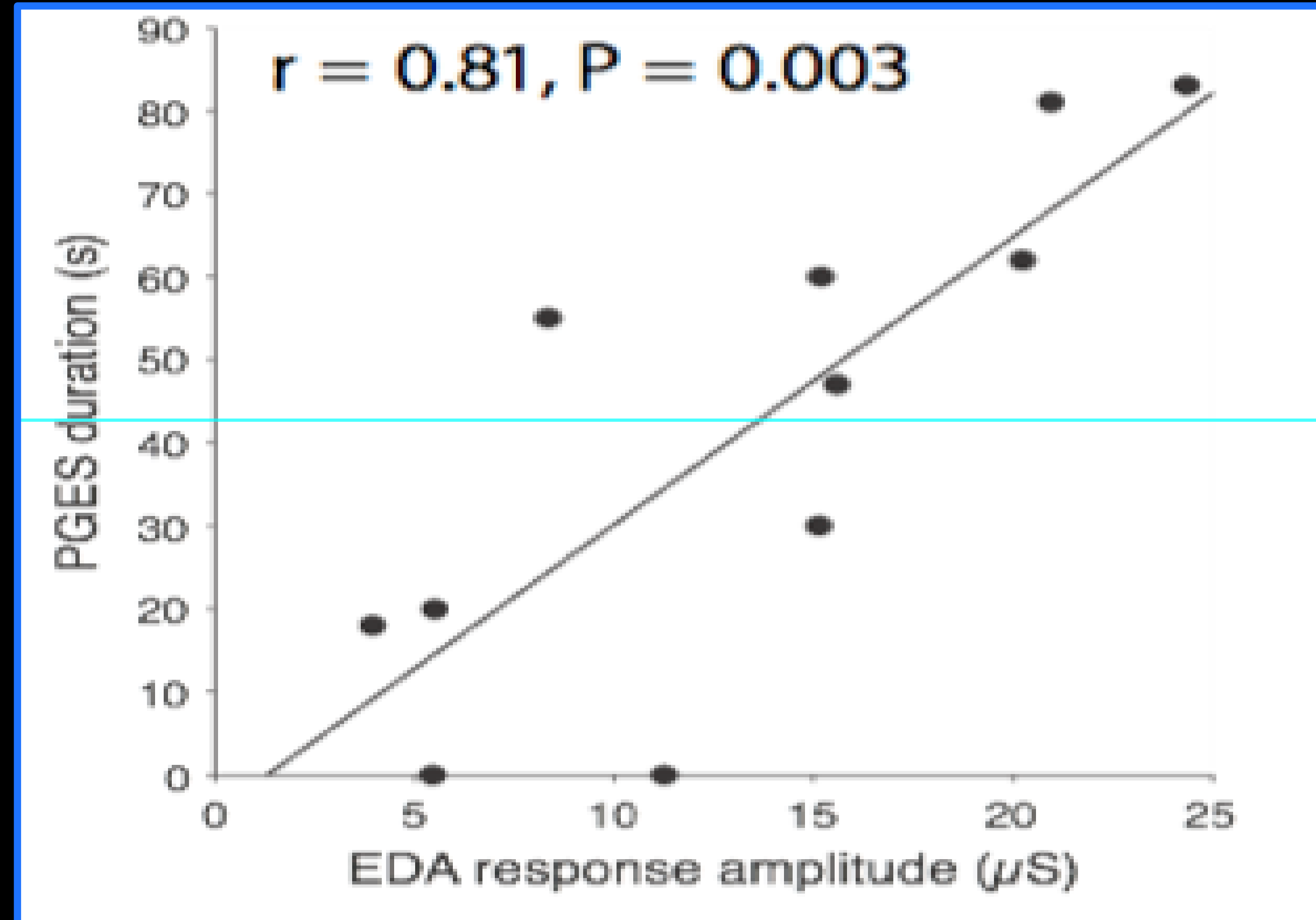
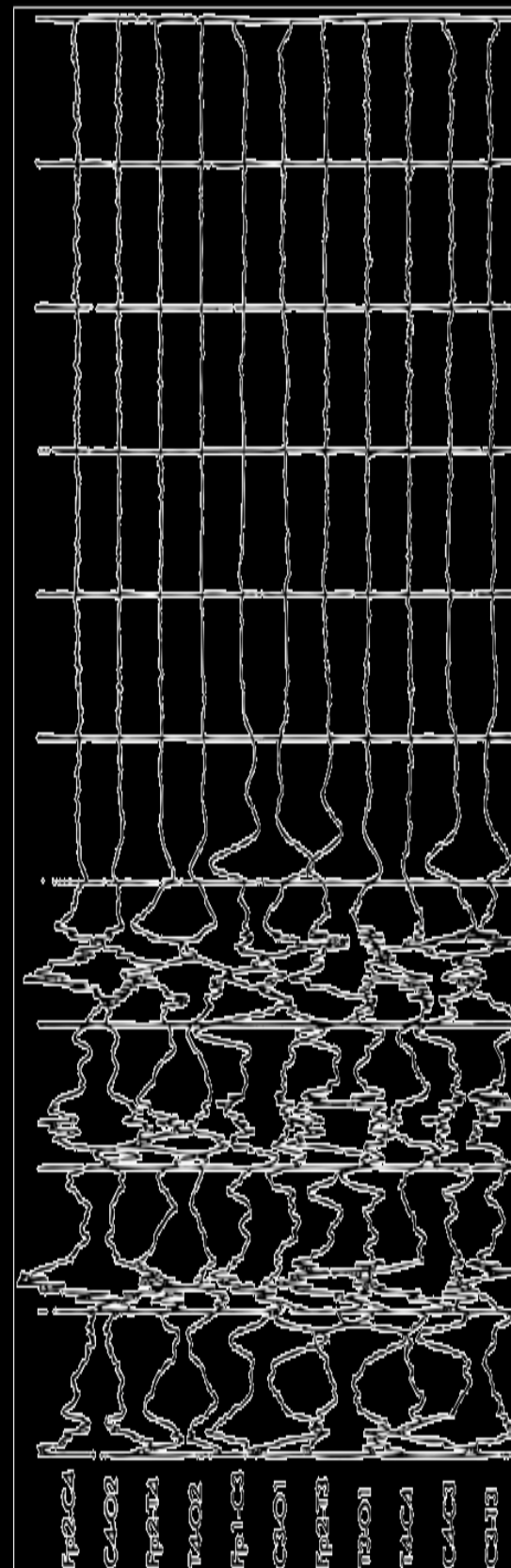
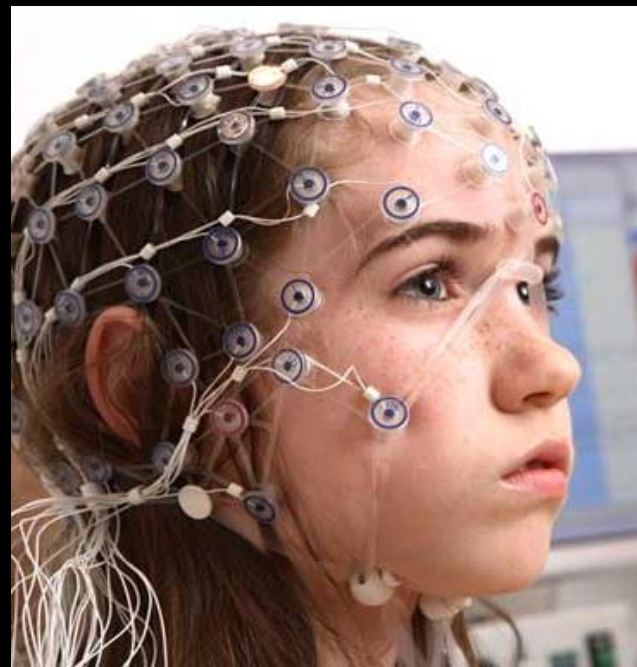


Neurologic diseases that cause death (Thurman et al. 2014)

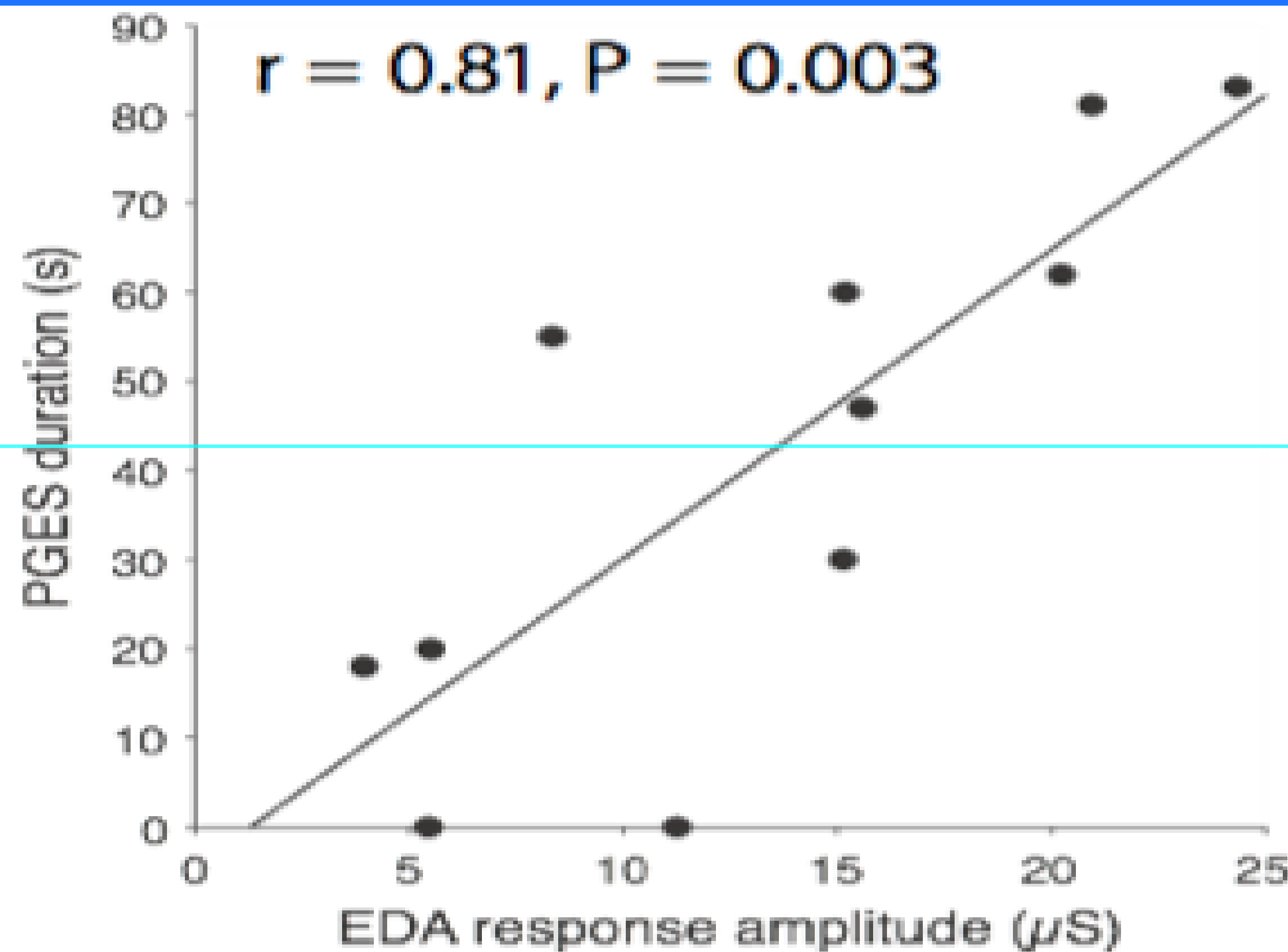
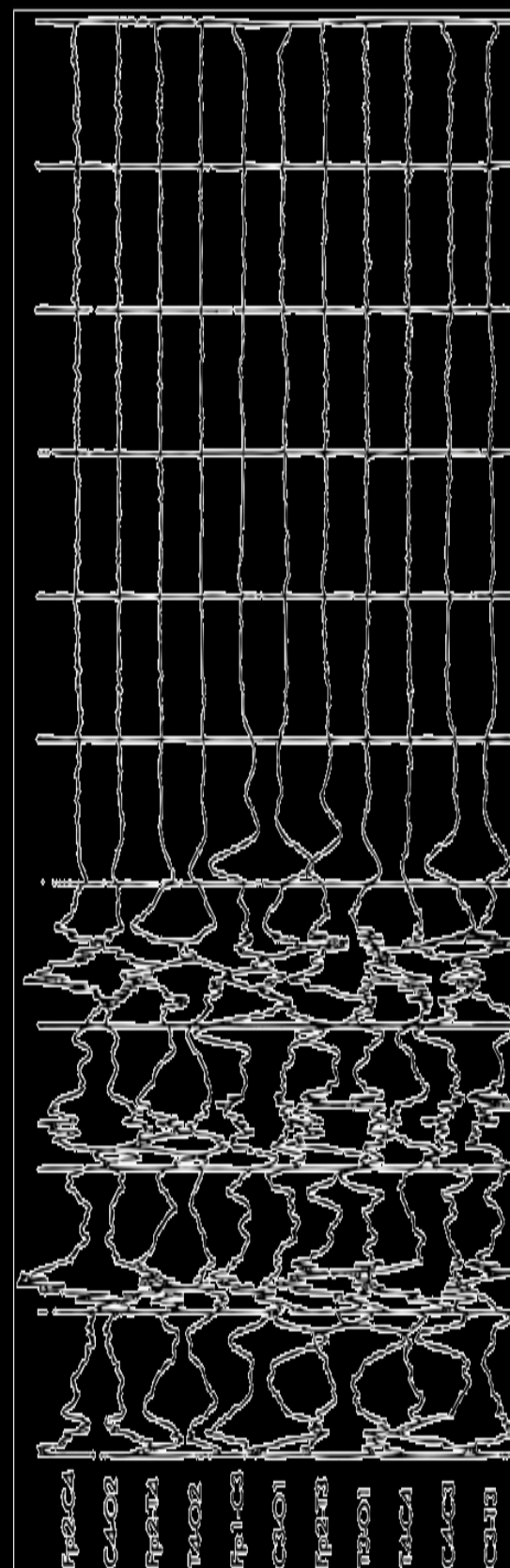
Post-ictal generalized EEG suppression (PGES) was found in 100% of monitored cases of SUDEP. *MORTEMUS* study by Ryvlin et al., Lancet Neurology 2013.



PGES =
Post-ictal
Generalized
EEG
Suppression



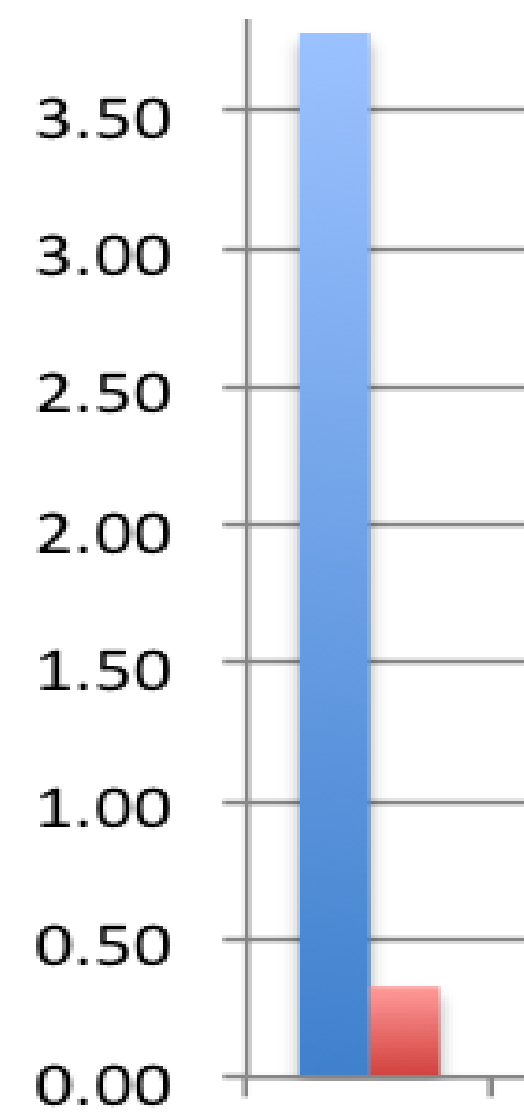
The longer the brain waves are suppressed, the bigger the signal on the wrist!



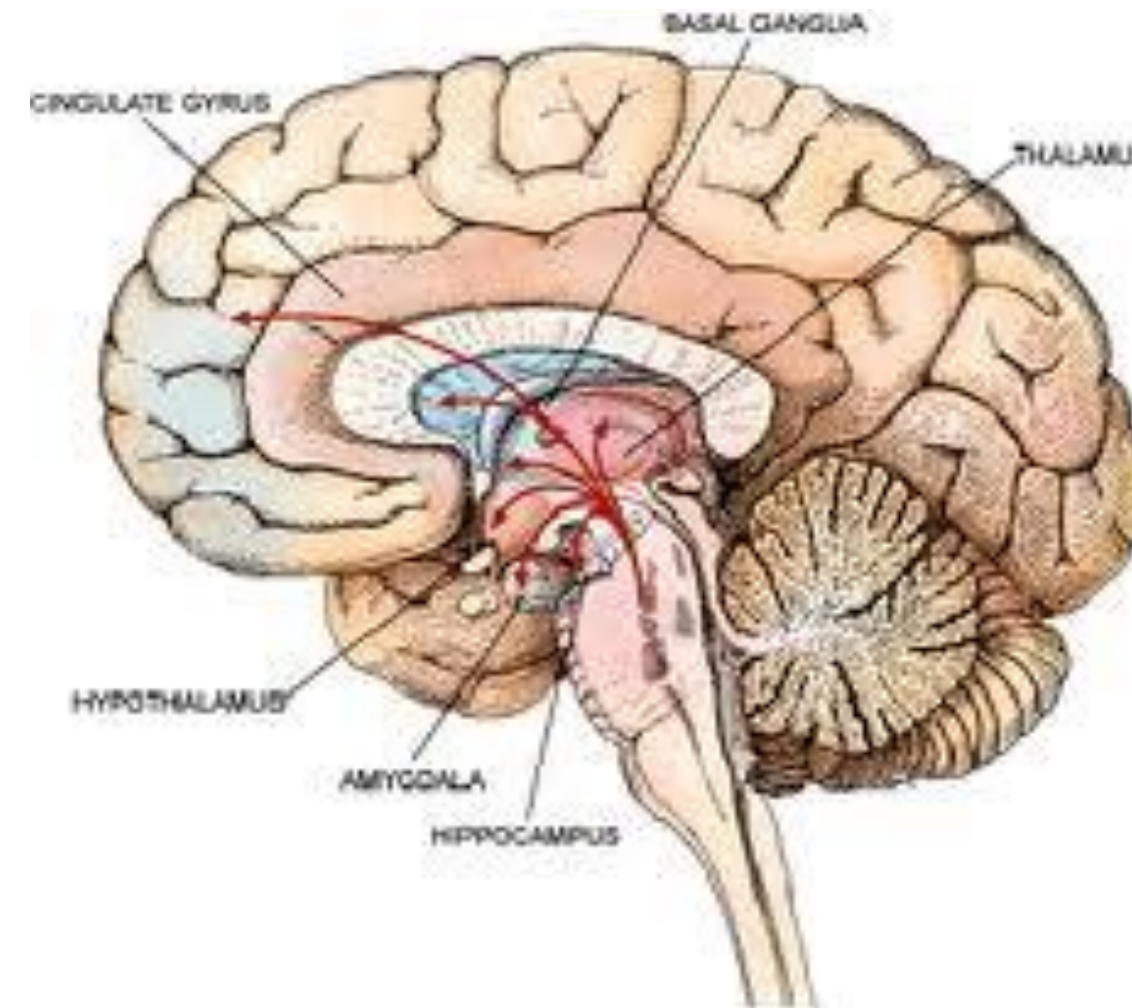
The longer the brain waves are suppressed, the bigger the signal on the wrist!

**Stimulating left
amygdala gives
largest left-palm
EDA**

■ Left Skin Conductance

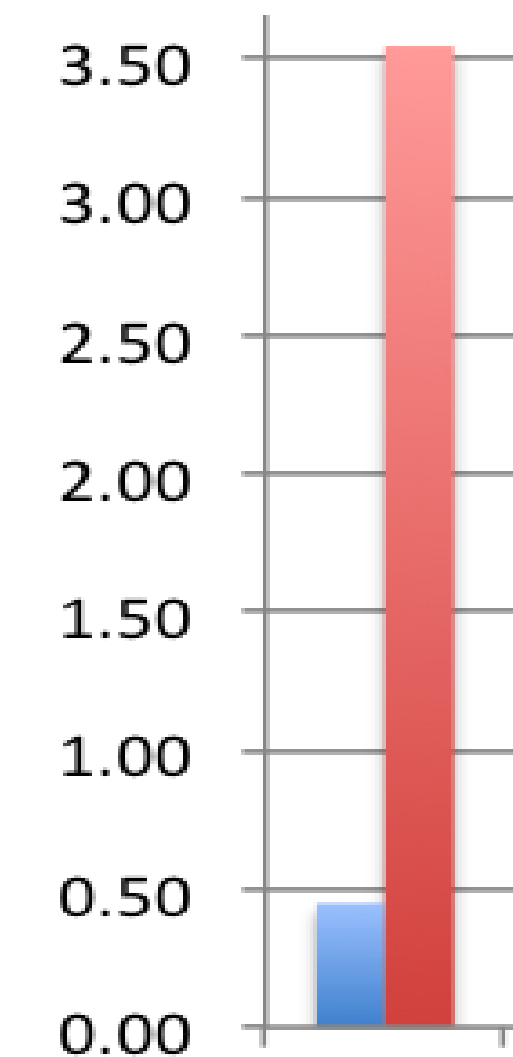


L Amyg



**Stimulating right
amygdala gives
largest right-palm
EDA**

■ Right Skin Conductance



R Amyg



Seizures are like little electrical fires in your brain
SUDEP = Sudden unexpected death in epilepsy, every 7-9 minutes, more deaths than house fires

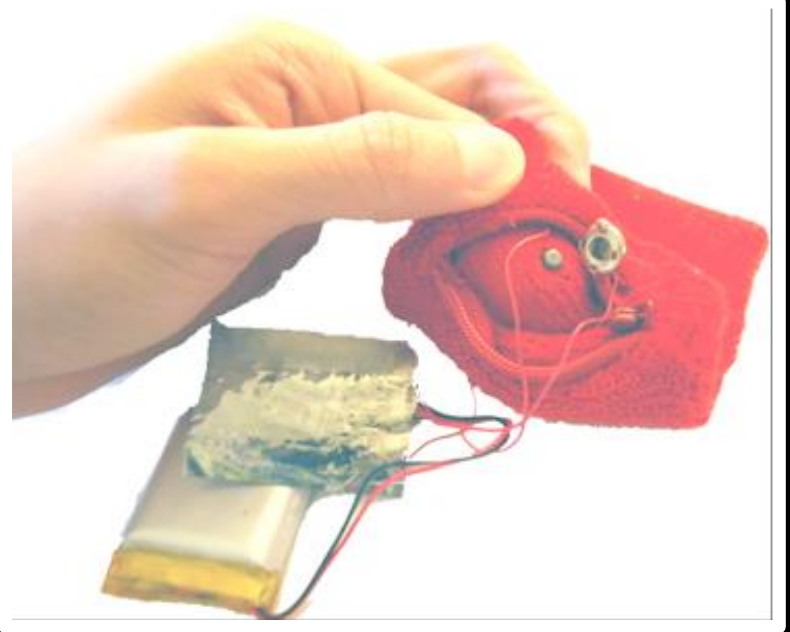


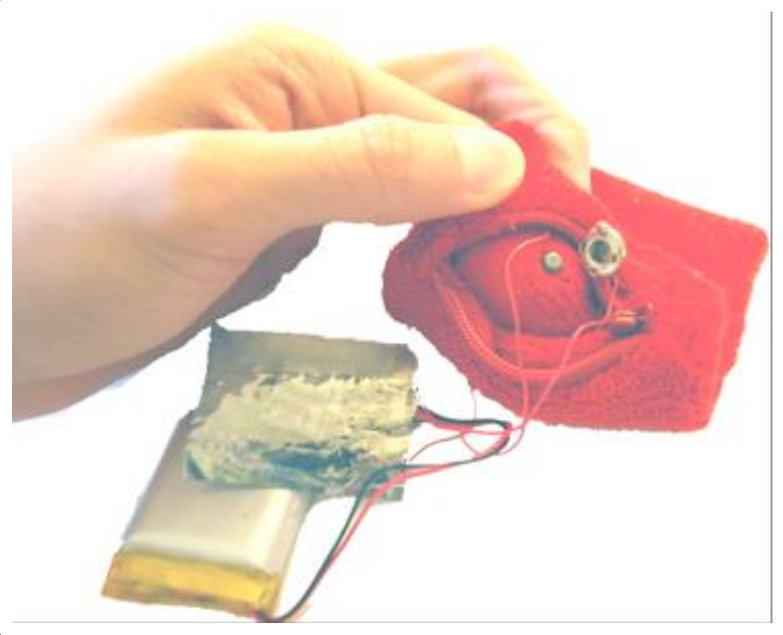
**An alert might prevent
seizure deaths**

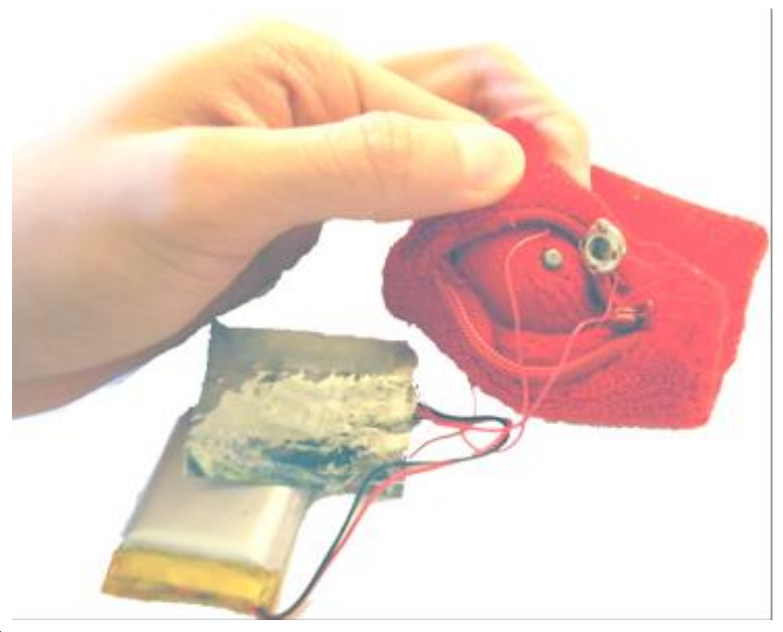


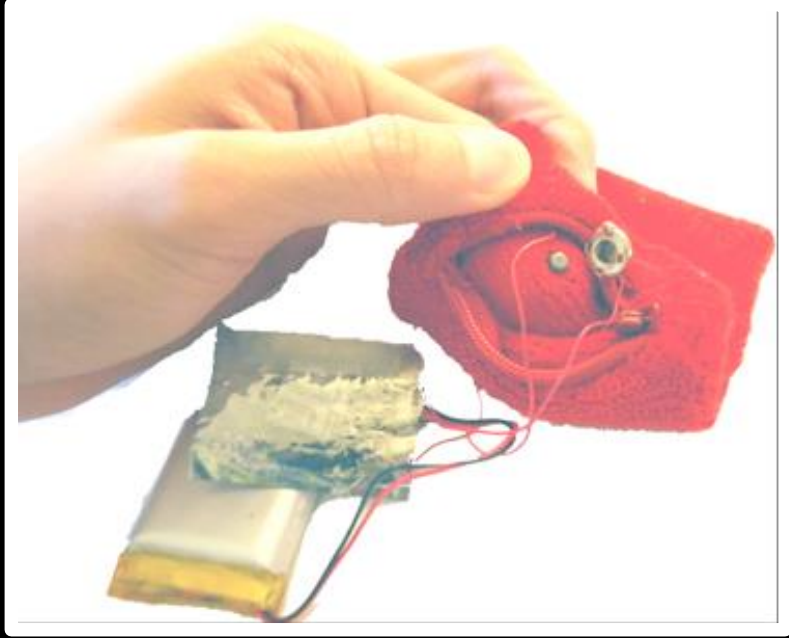
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Embrace



Physical Activity

Sleep/Wake

Time

Temperature

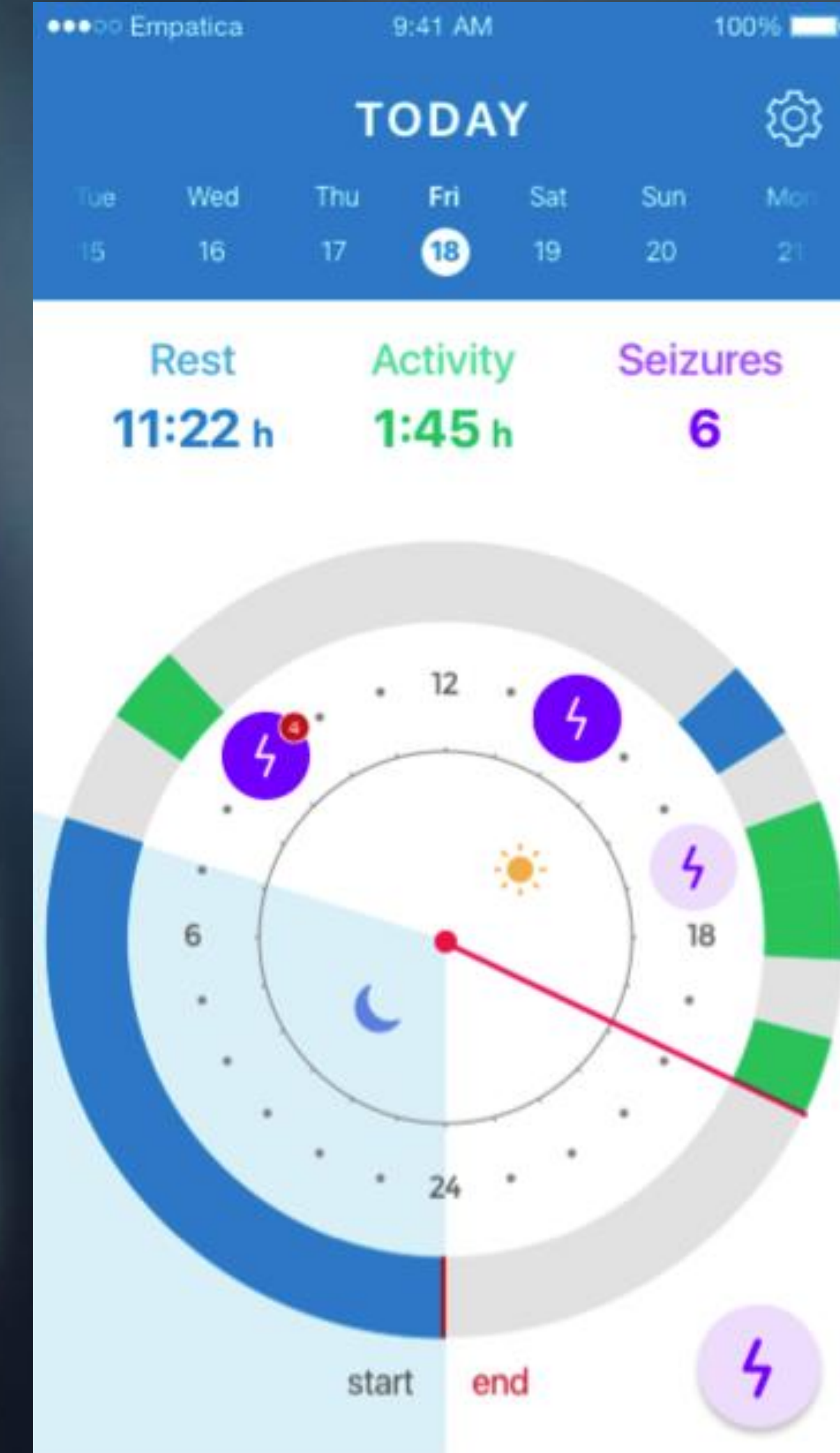
**Seizure detection
(USA: in clinical trial)**

Alerts

Water-resistant

Stress (coming)

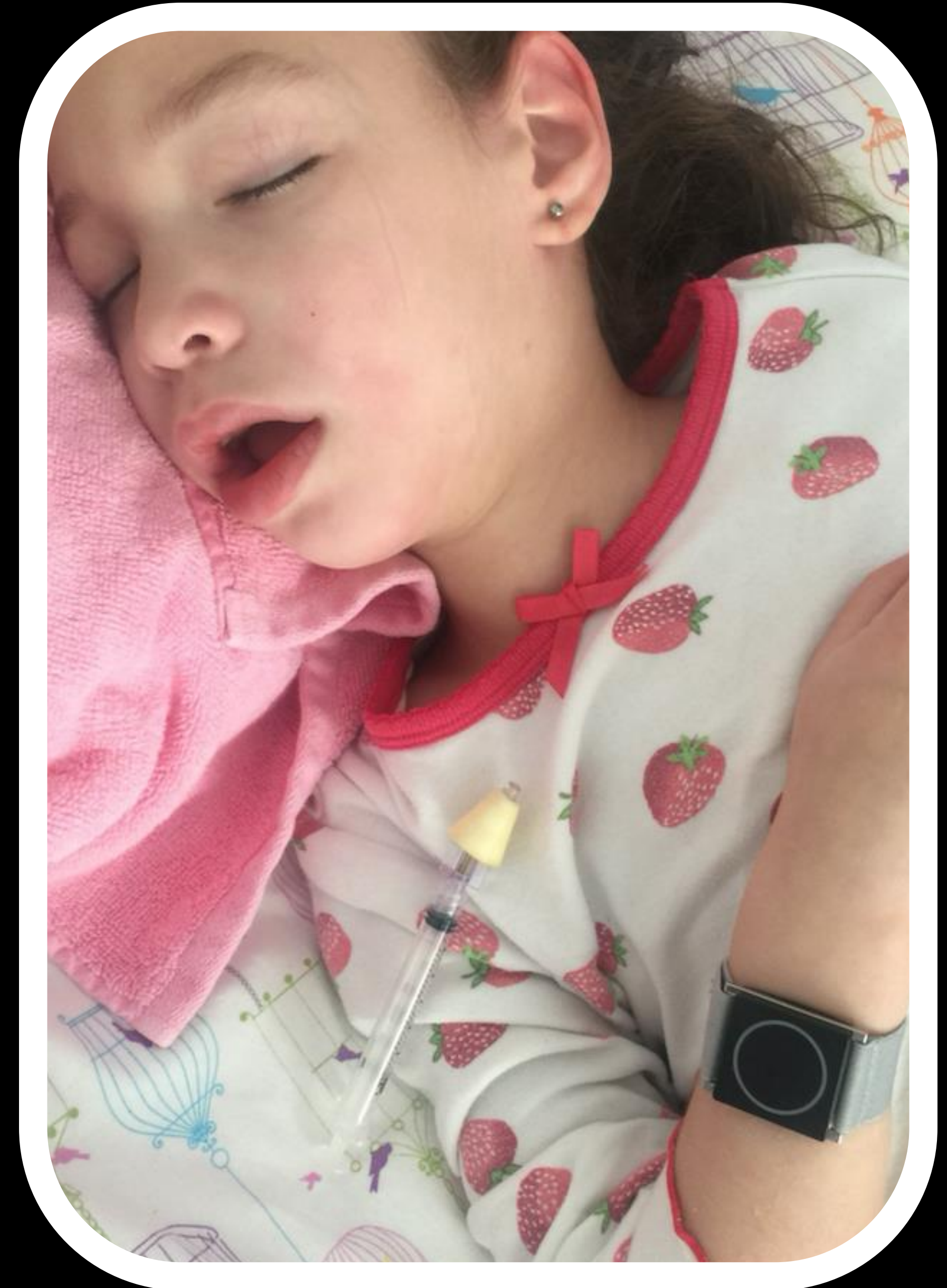
API (coming)



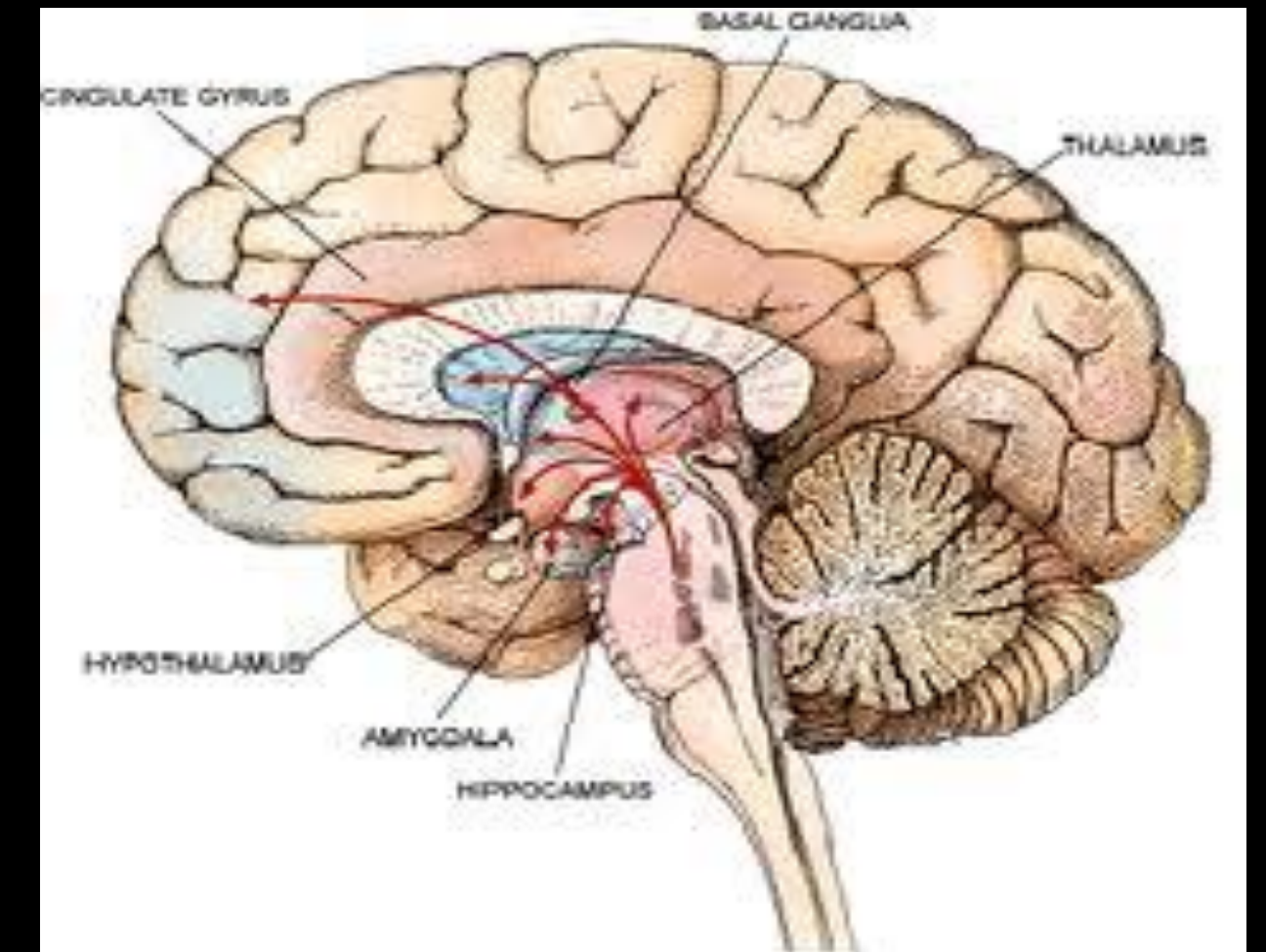
Email from a beta user:

The Embrace is impressive! We got another alert this morning, ran to her room and **she was face down with a seizure/not breathing!**

We repositioned her and **she is now pink and sleeping.**



Deep brain/neural activity -> signals on wrist?



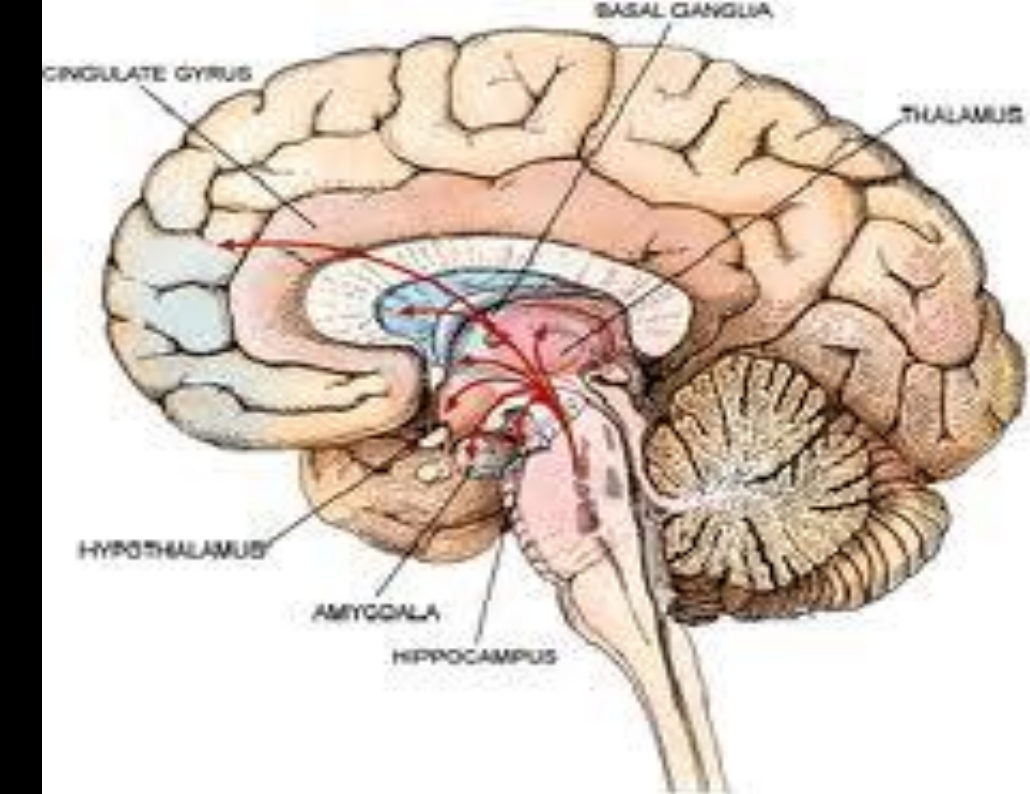
Embryo has three tissue types:

Ectoderm	Skin and neural
Endoderm	Digestive and respiratory track
Mesoderm	Muscle and bone

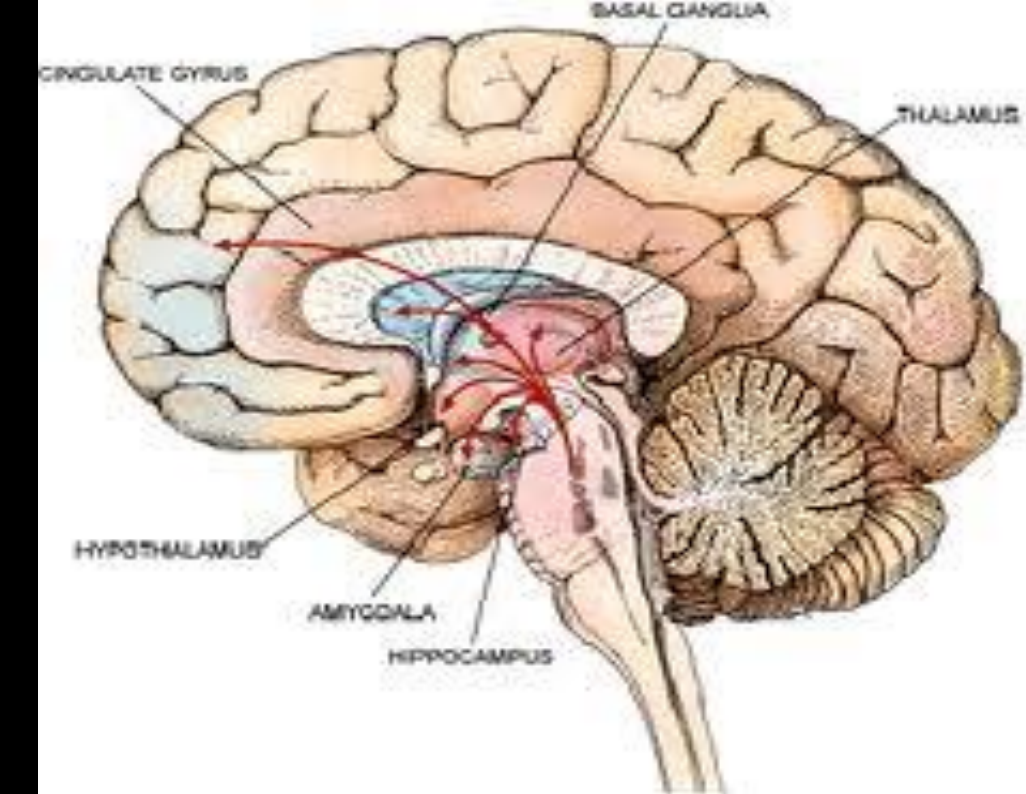
**What my former
boss always
asked for....**



Growing challenge: the future of mood

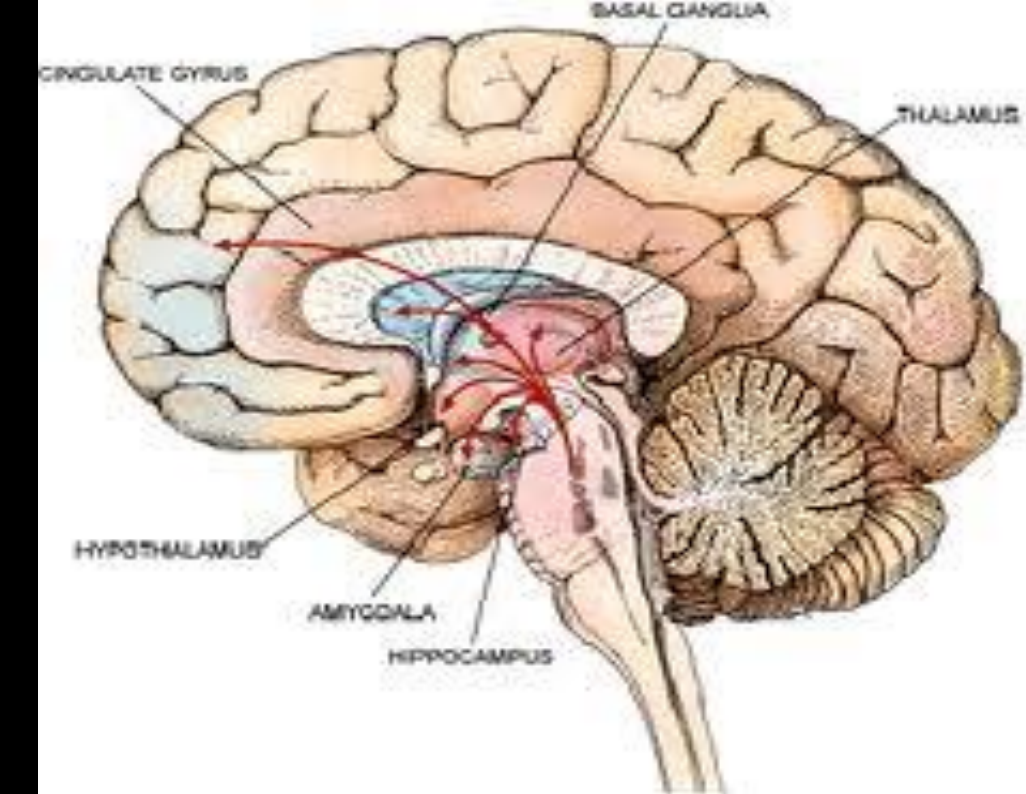


Growing challenge: the future of mood



Major Depressive Disorder is the leading cause of **disability** in the U.S. for ages 15-44.

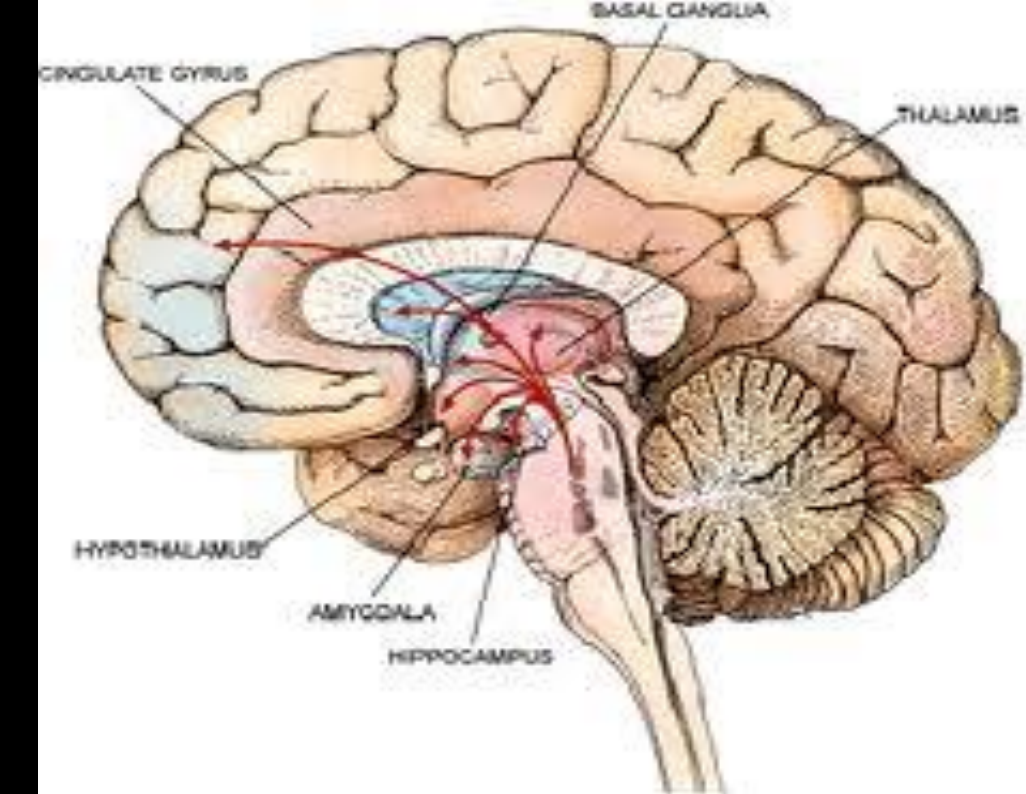
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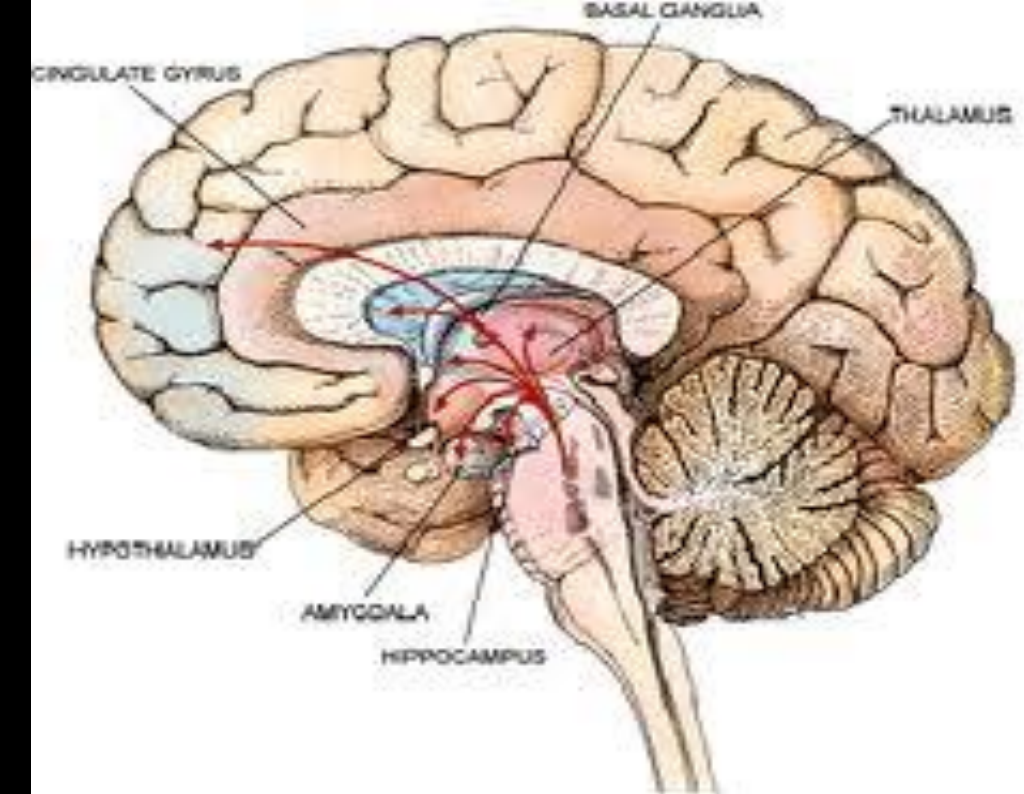
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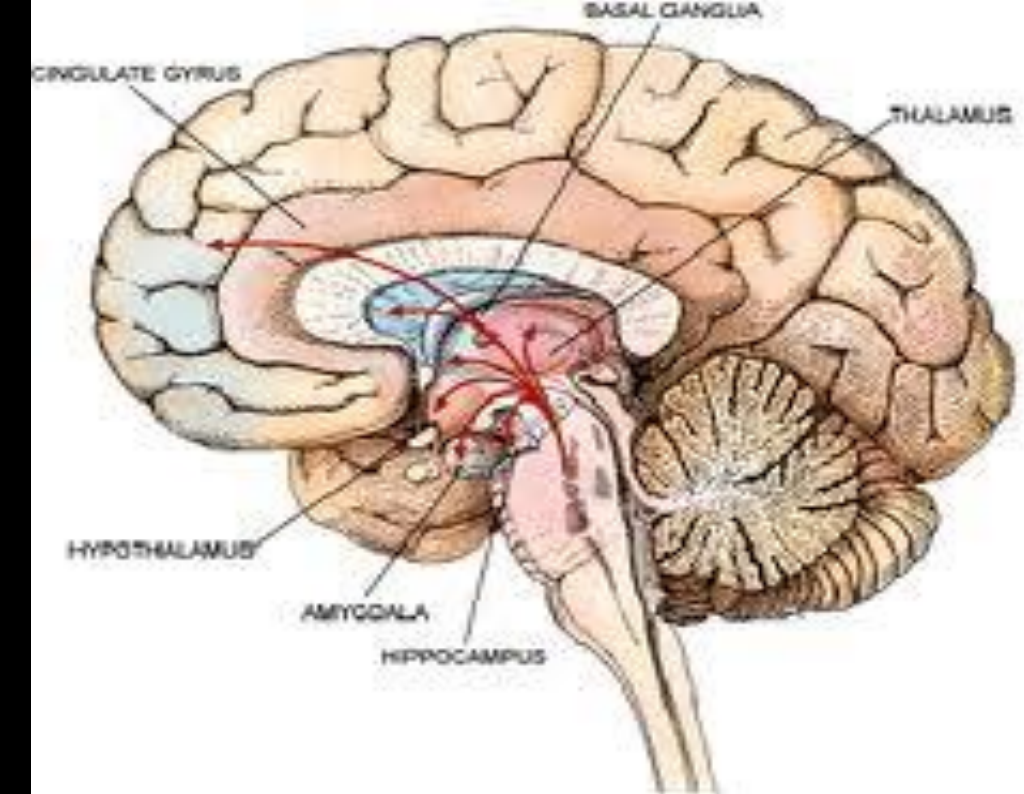
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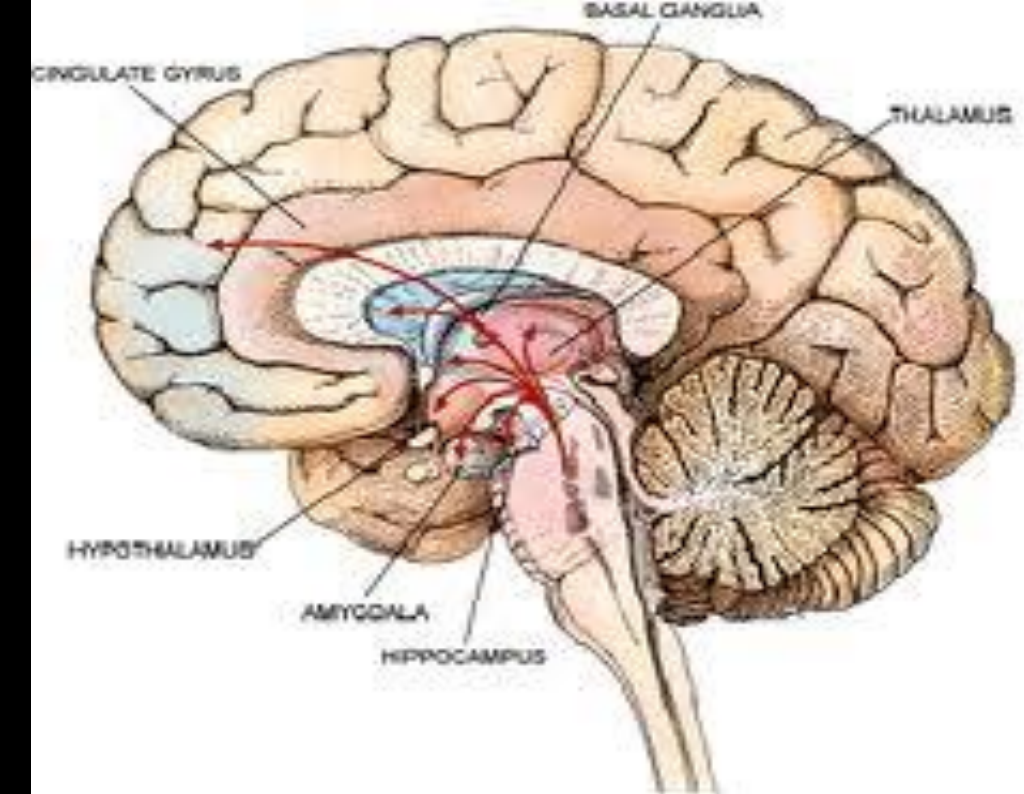


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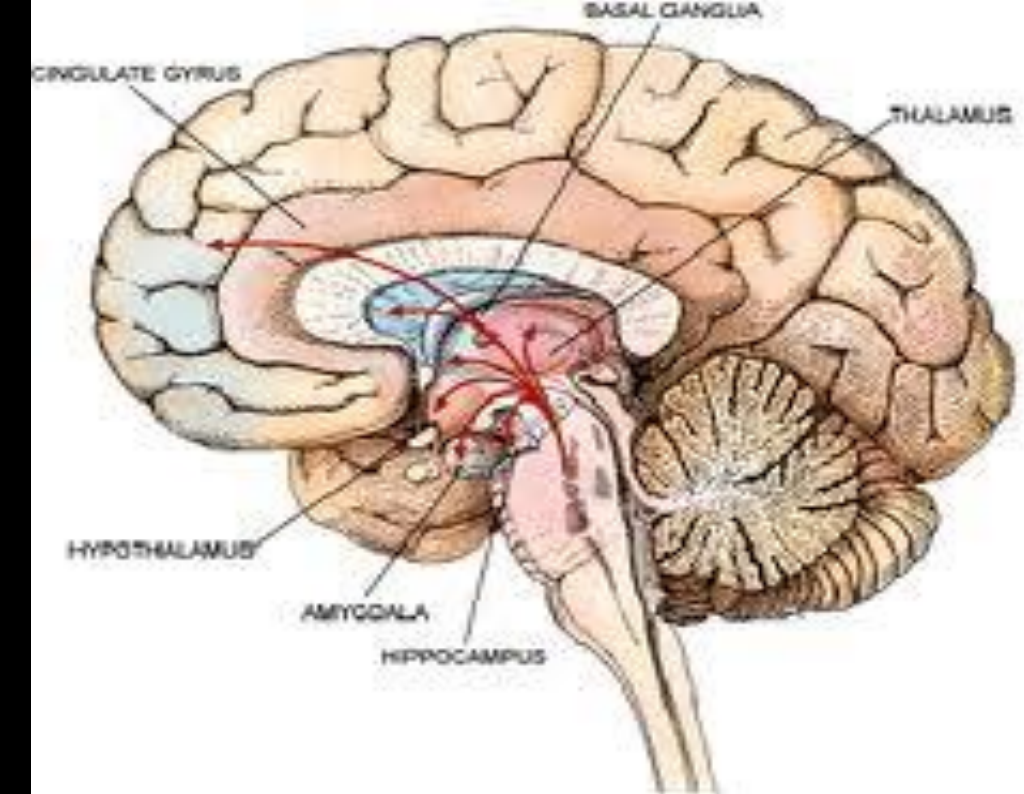


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- suicides tripled for young girls, aged 5-14

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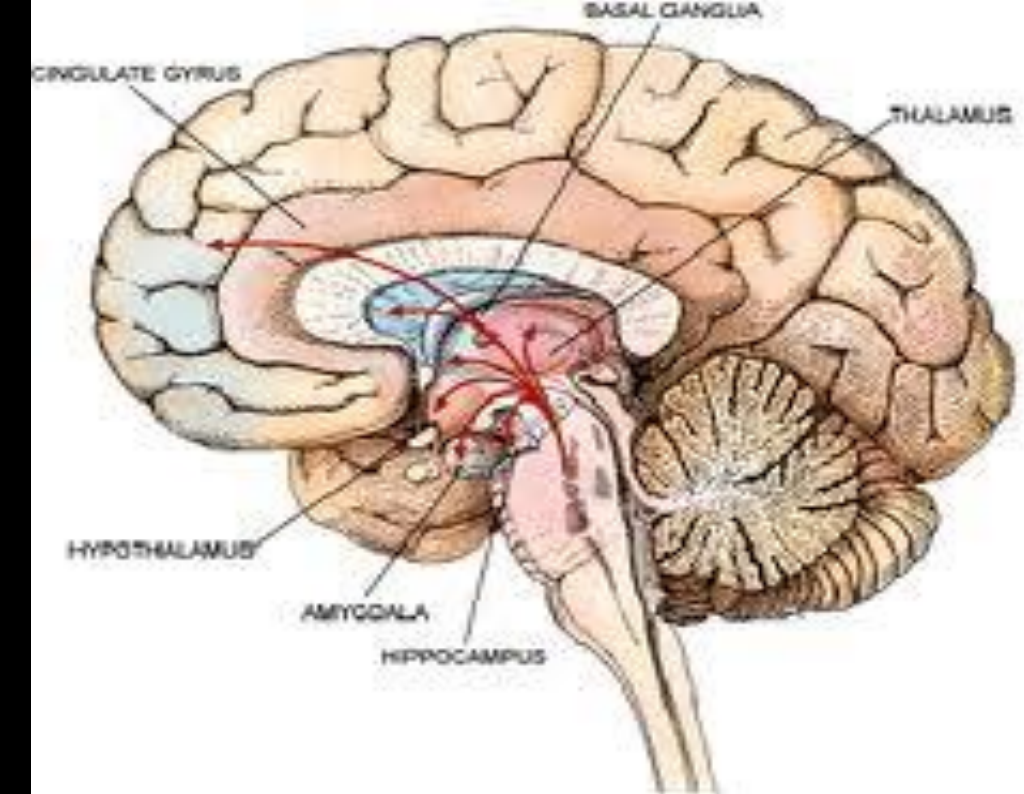
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Suicide is higher in developing countries and growing worldwide (WHO, 2012, 2014)

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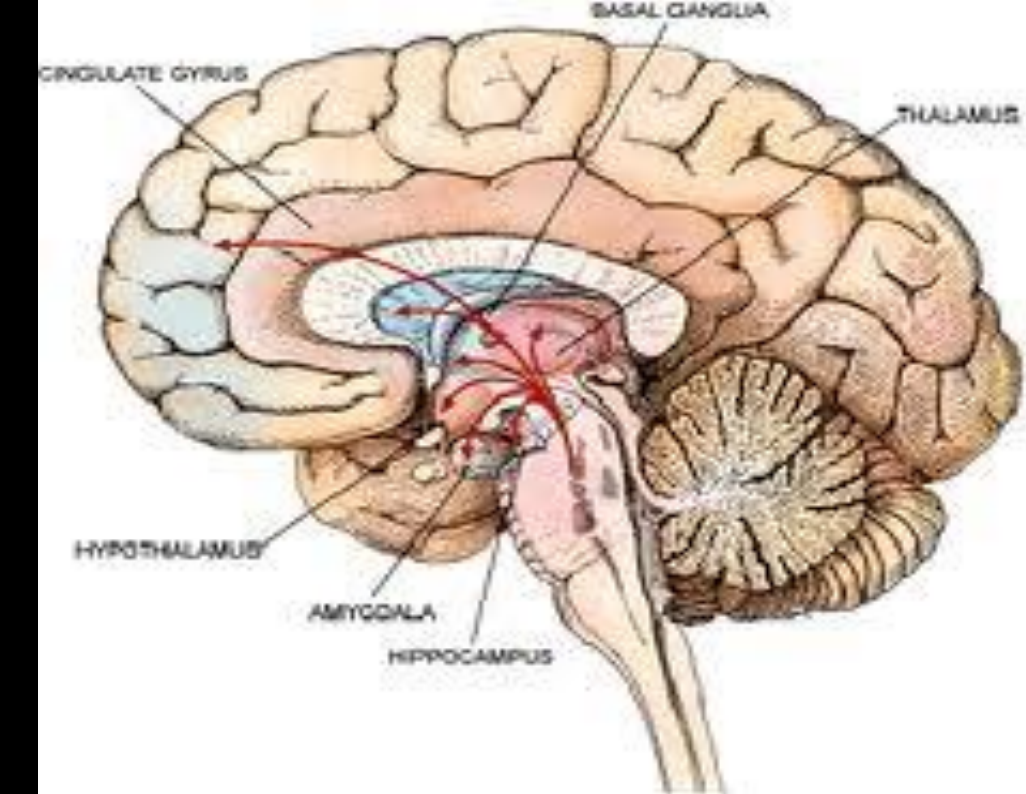
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- By 2020, 1 suicide will happen every 20 seconds

Growing challenge: the future of mood



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Suicide is higher in developing countries and growing worldwide (WHO, 2012, 2014)

- By 2020, 1 suicide will happen every 20 seconds
- By 2030, disability and lives lost from **depression** will be greater than from **cancer, accidents, war, and stroke.**



Ambulatory Measurement

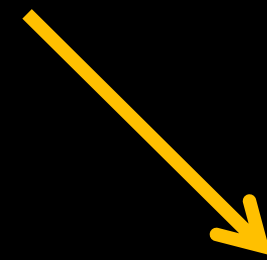
Physiology

Behavior

Social Interaction

Environment

Experience Sampling

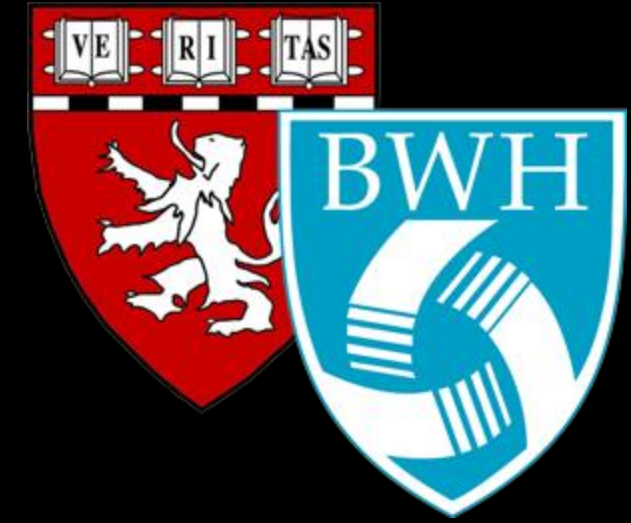


Lab measurement

Standardized questionnaires

Saliva (Melatonin)

Cognitive and Affective stress tasks



Ambulatory Measurement

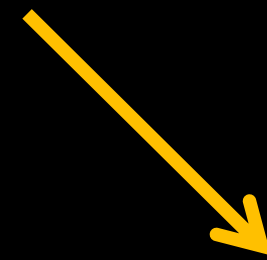
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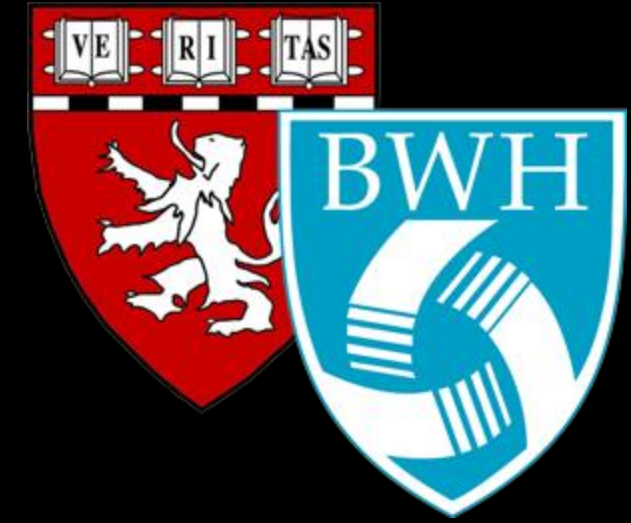
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~1.2 Billion samples per person/year



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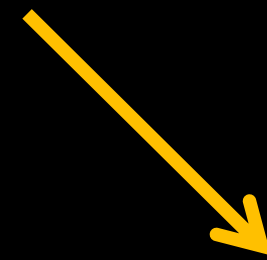
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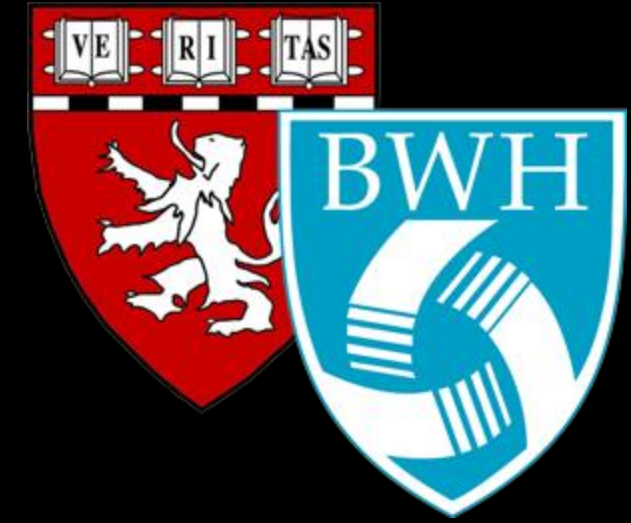
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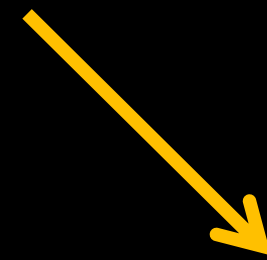
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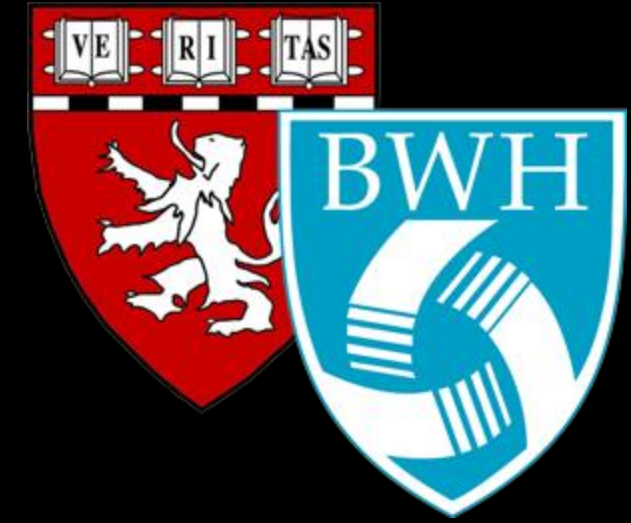
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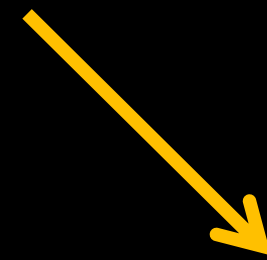
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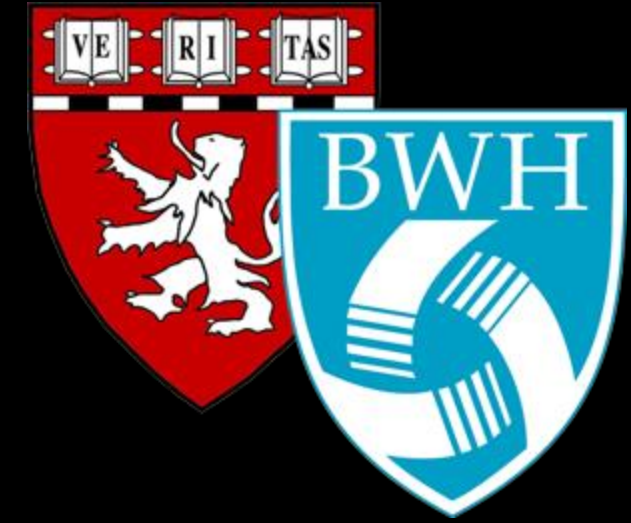
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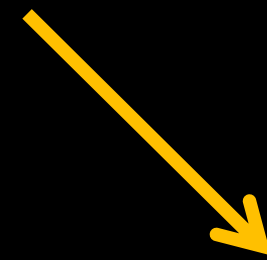
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Experience Sampling



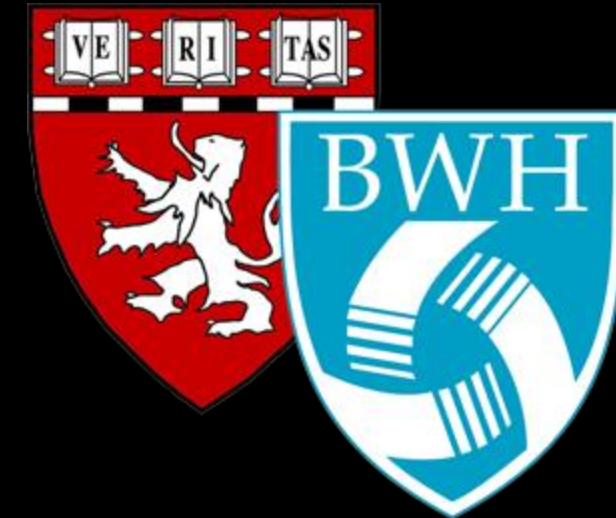
Lab measurement

Standardized questionnaires

Saliva (Melatonin)

Cognitive and Affective stress tasks

~1.2 Billion samples per person/year



Ambulatory Measurement

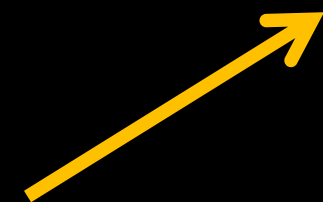
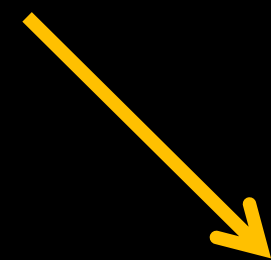
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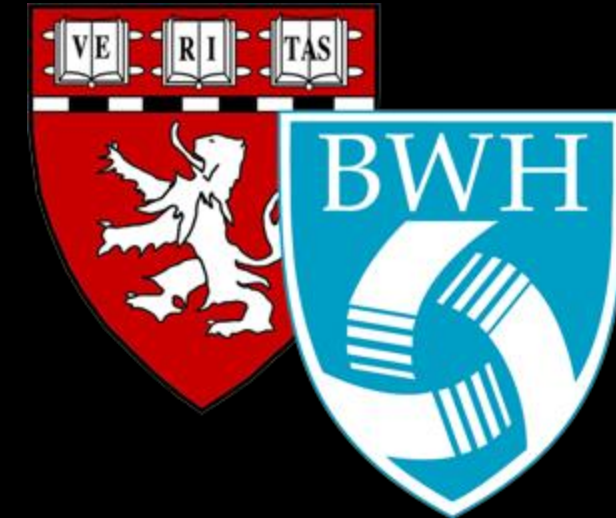
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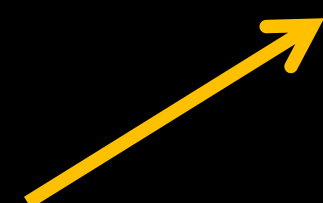
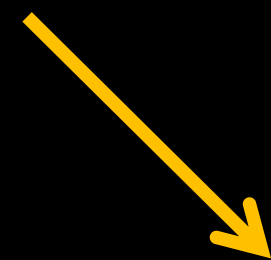
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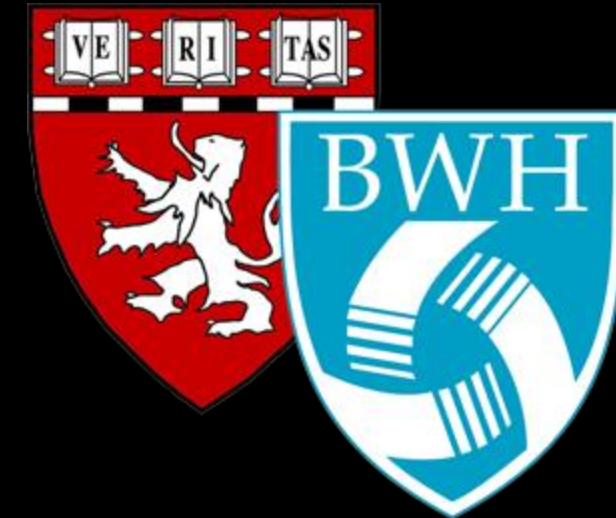


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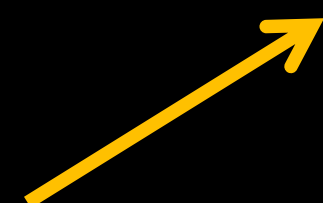
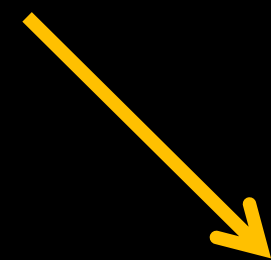
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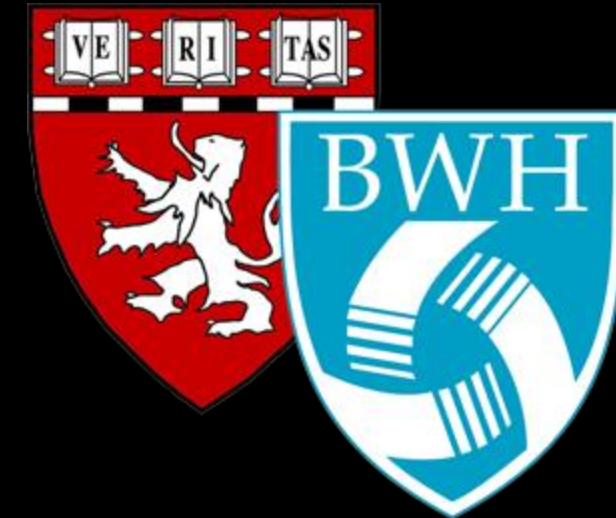
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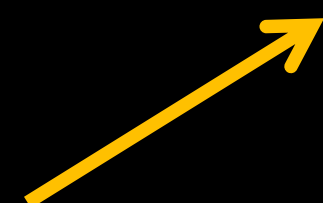
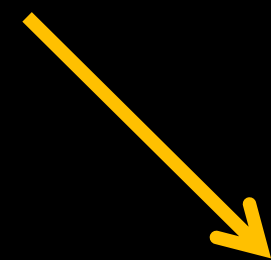
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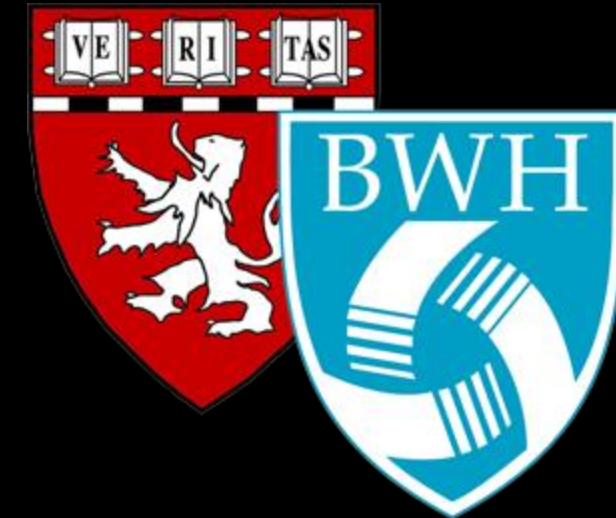
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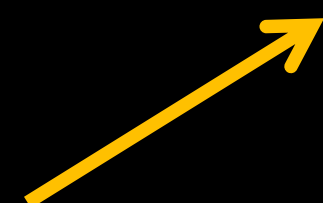
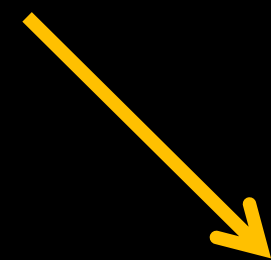
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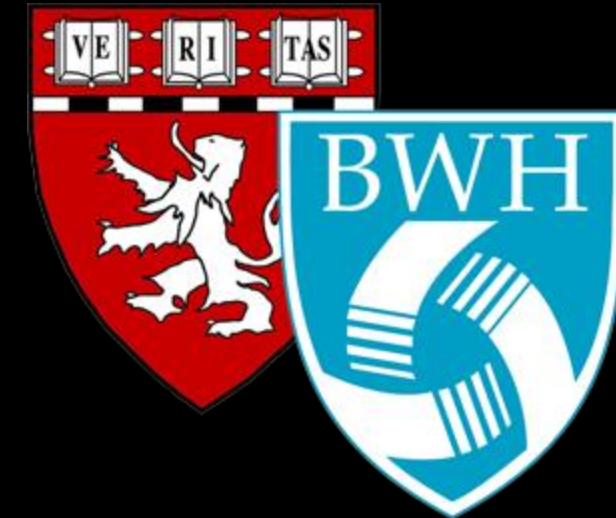
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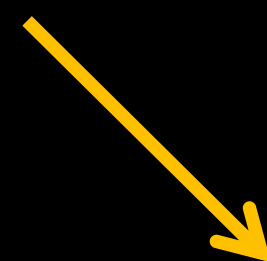
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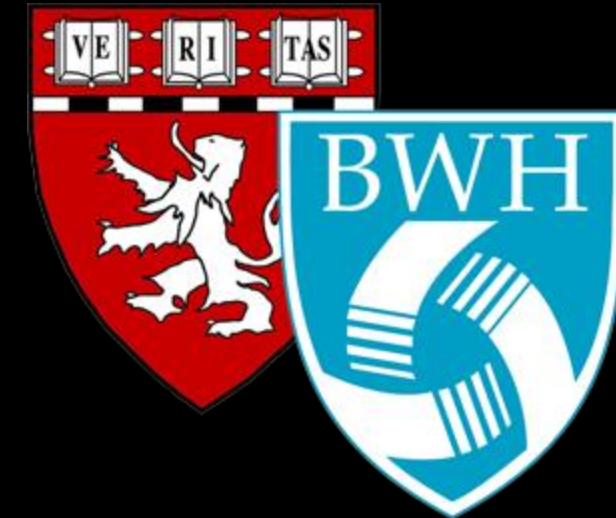
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Long-term monitoring & analysis



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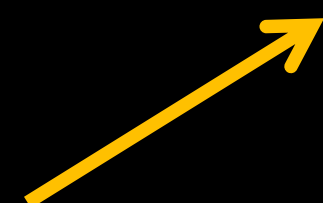
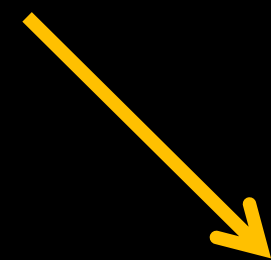
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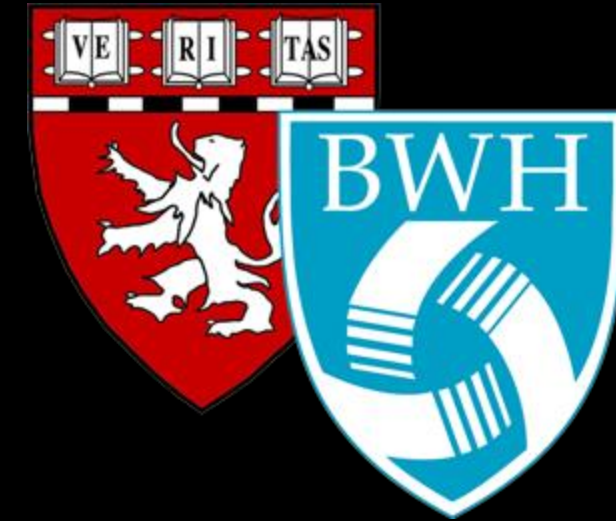
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Future: Forecast when you are likely to get sick or depressed

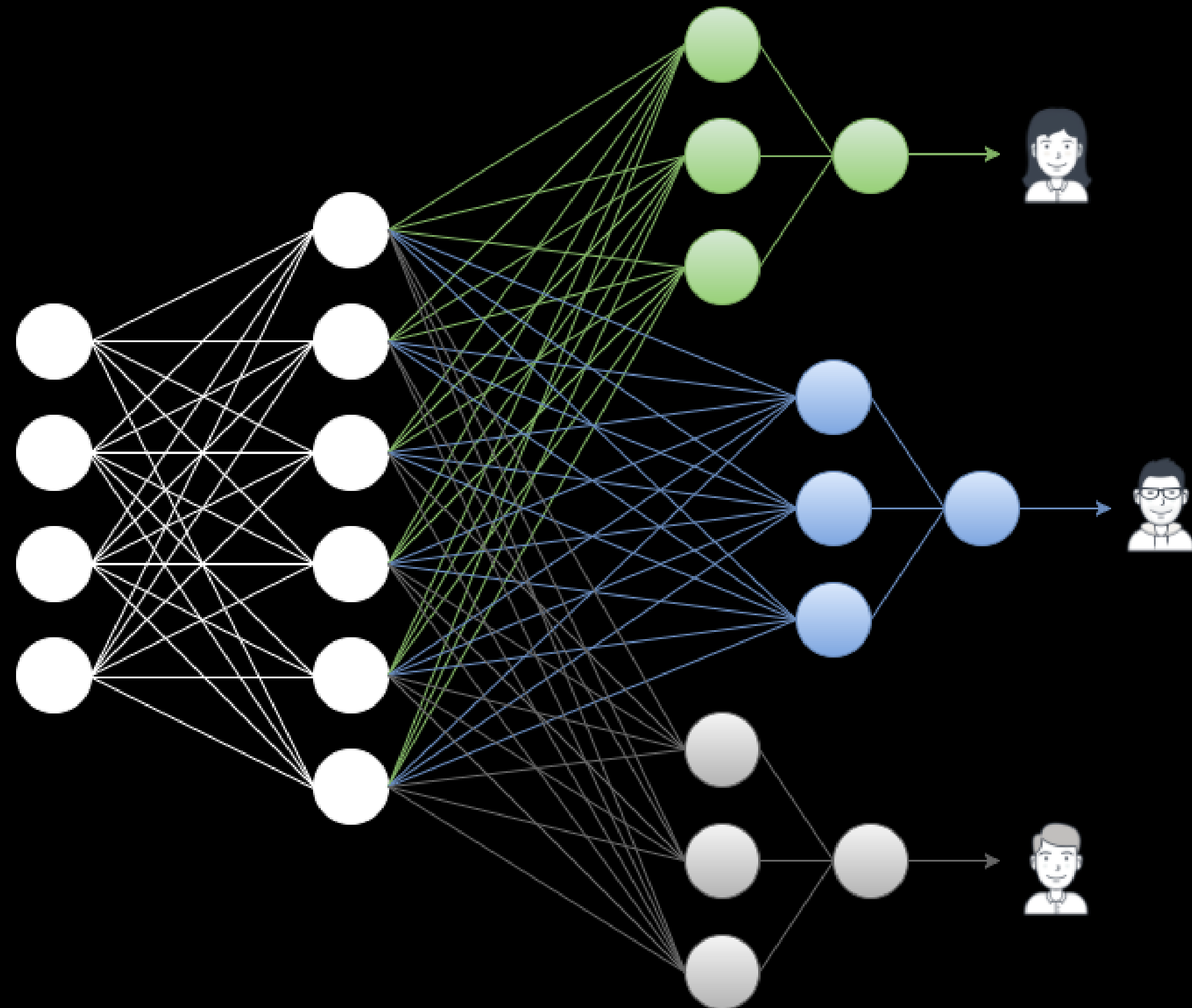


Long-term monitoring & analysis



~1.2 Billion samples per person/year

Multi-task Learning to Predict Stress, Health, & Happiness



- Each person's machine learning model includes insights from self and from others
- **Goal:** Predict your physical health, stress, and happiness from your wearable + smartphone data for TOMORROW NIGHT based on your data through today.
- **Accuracy: 82-87%**

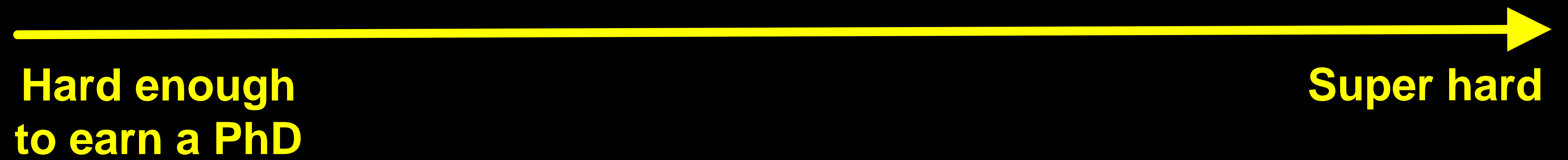
Multi-task deep neural network architecture

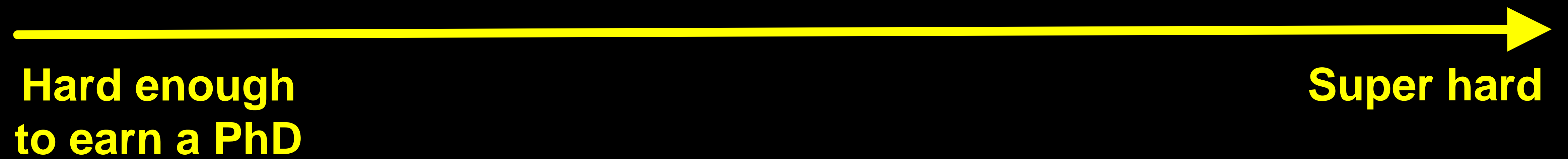




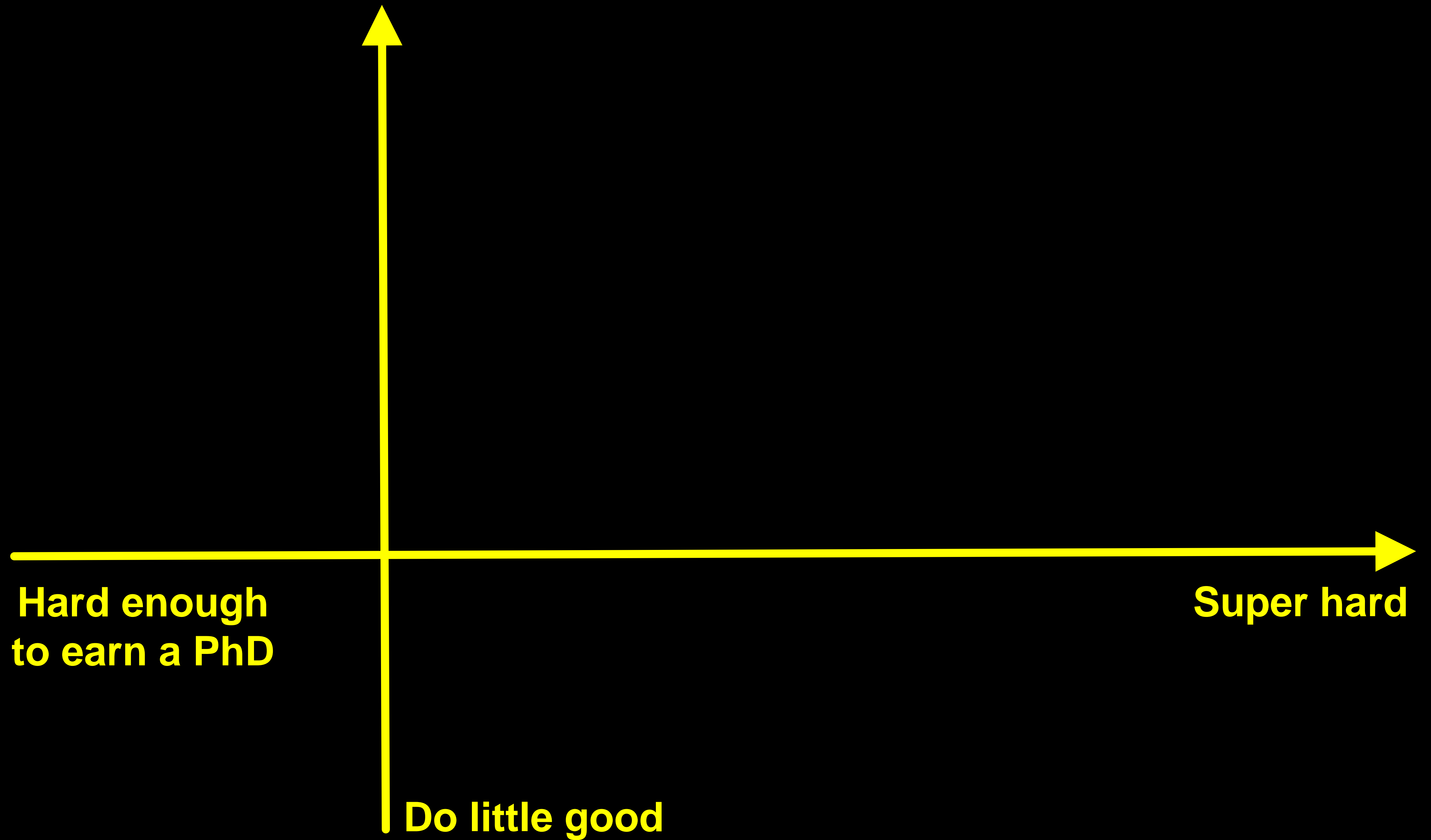


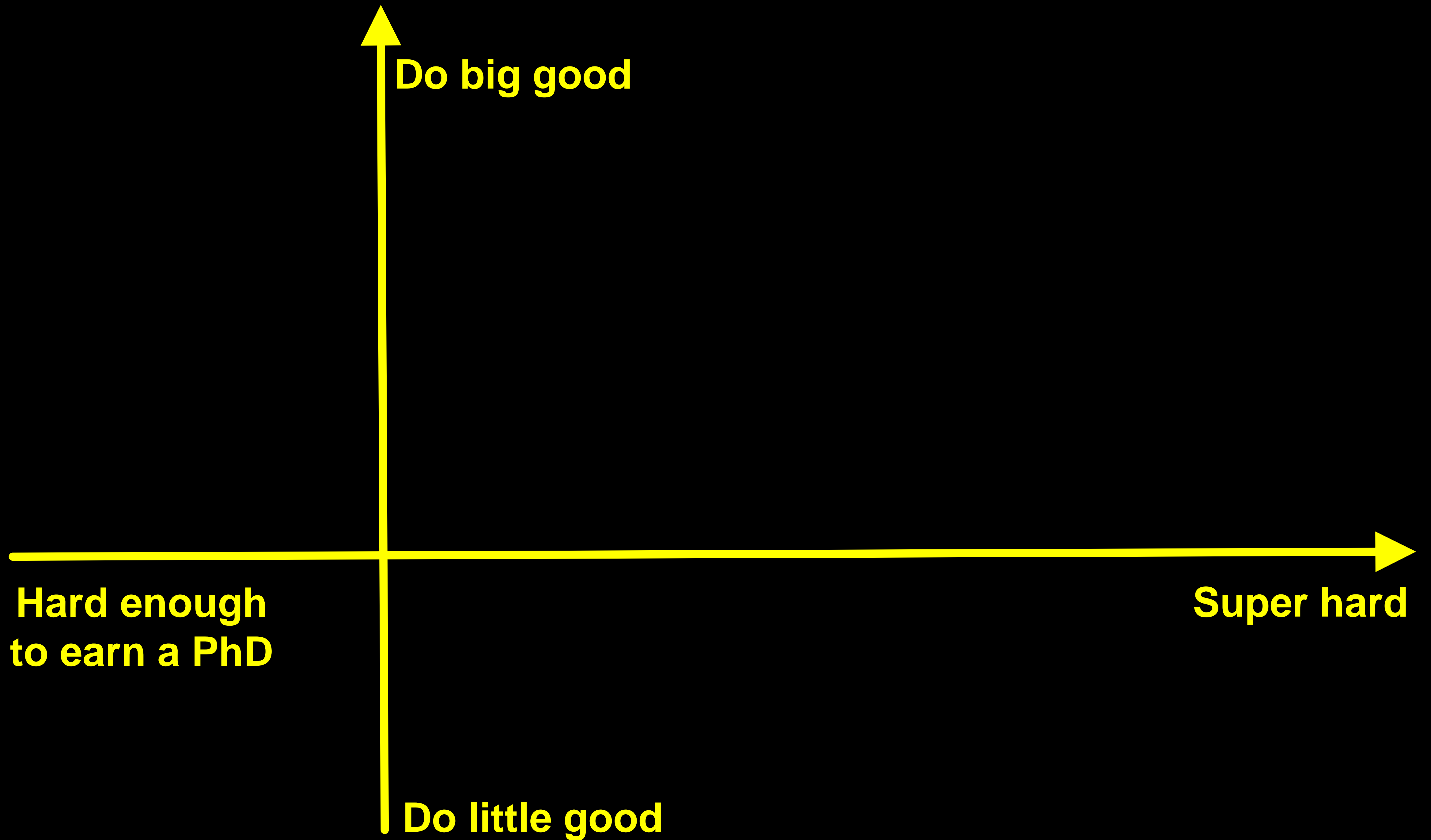
Idea: PREVENT 80% of Depression





DO NO EVIL?





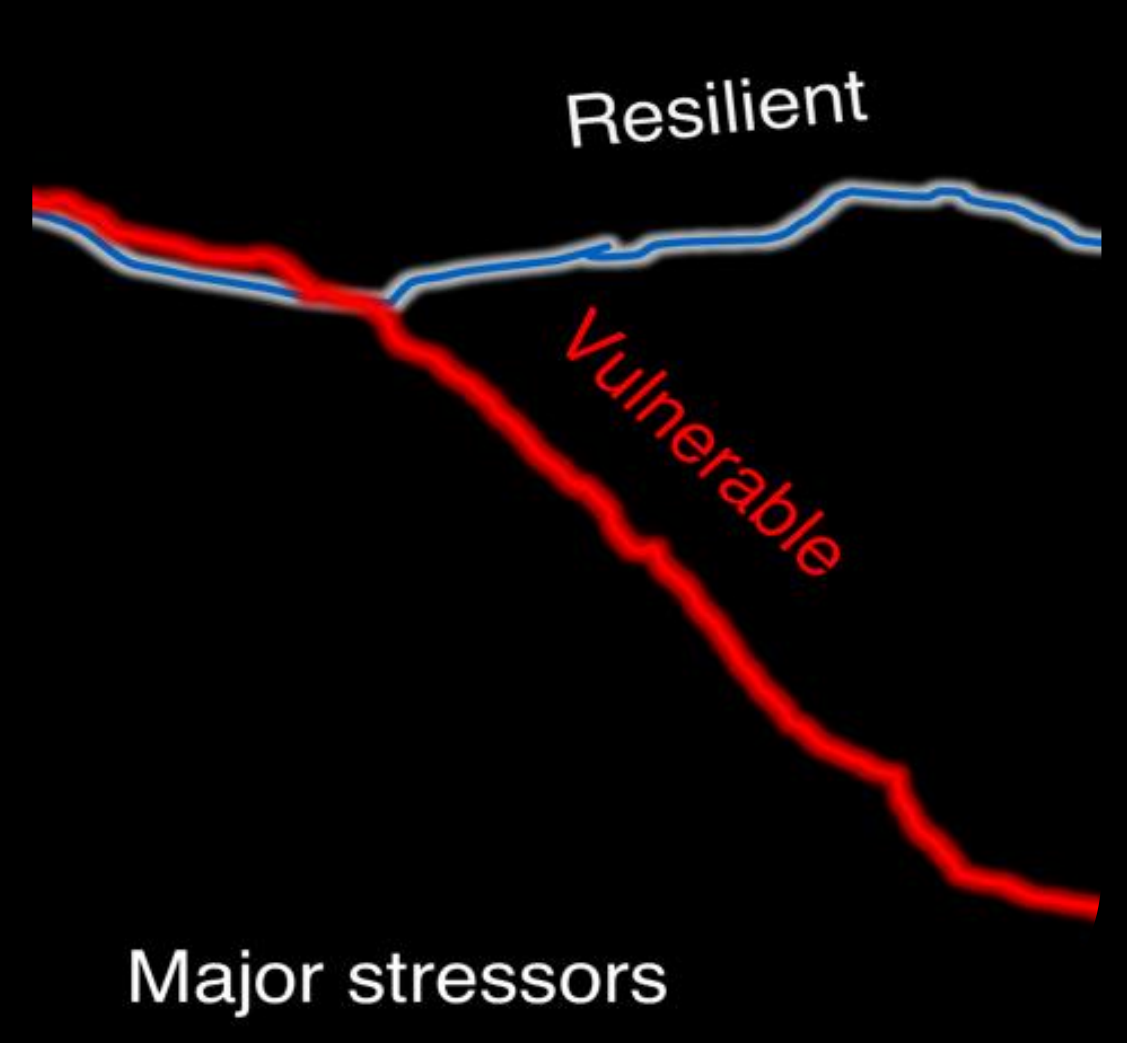
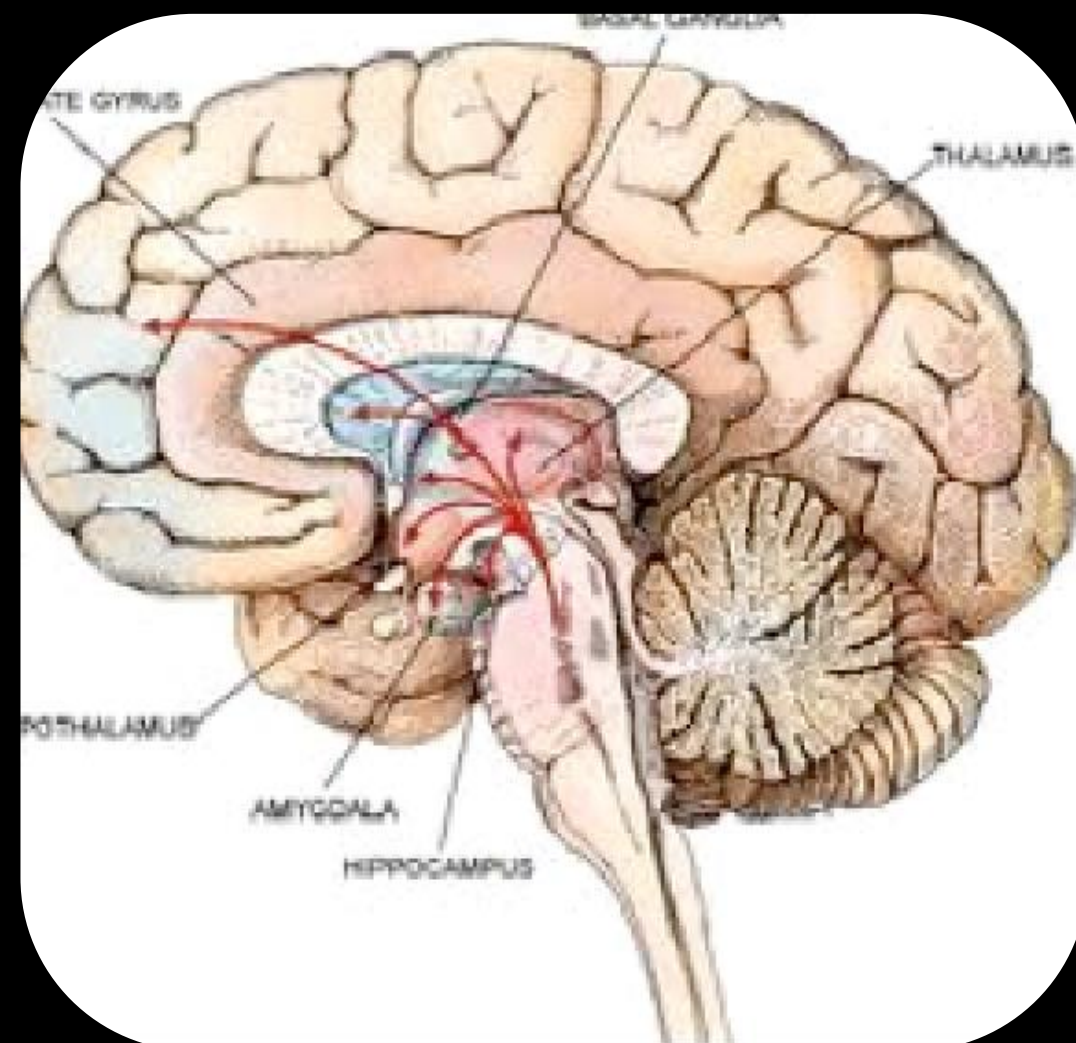
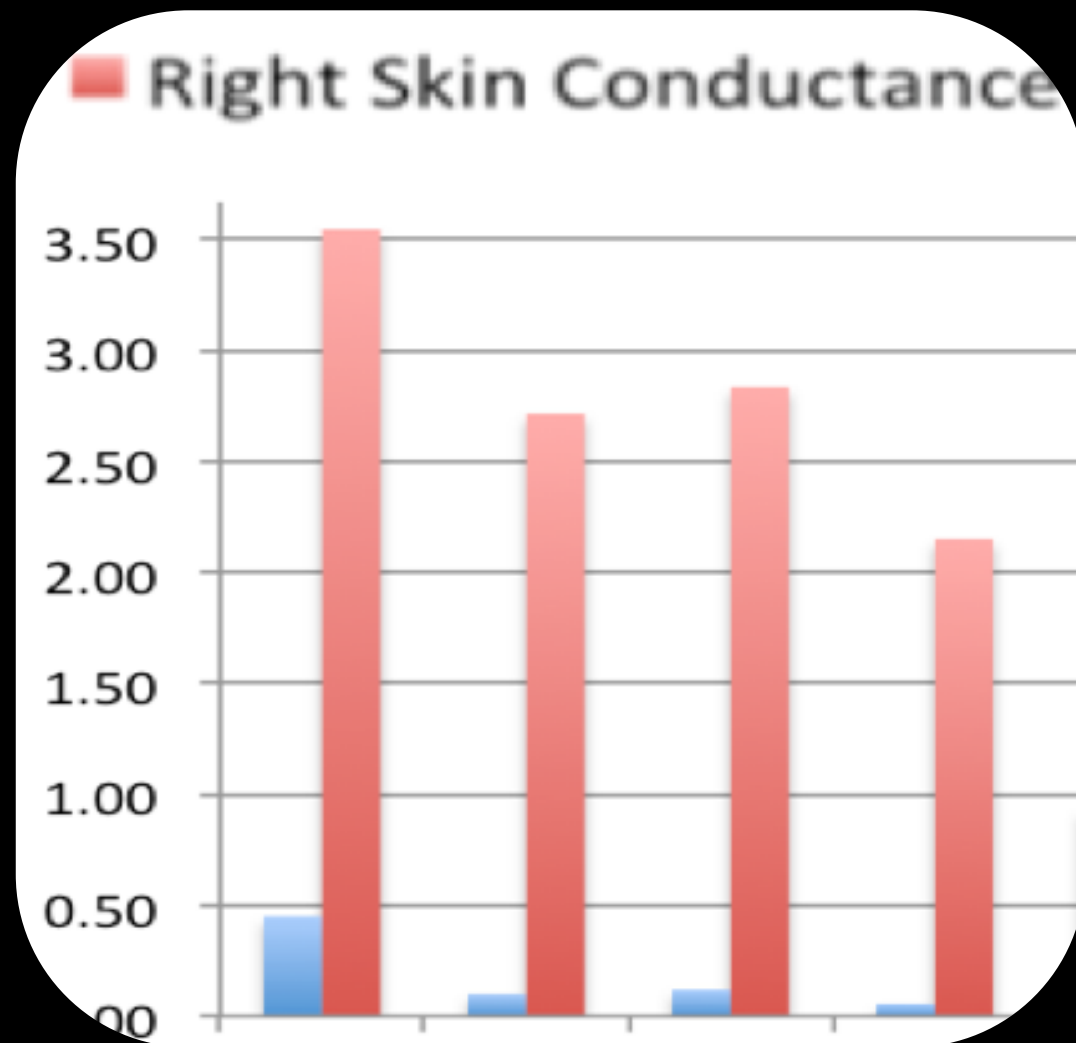
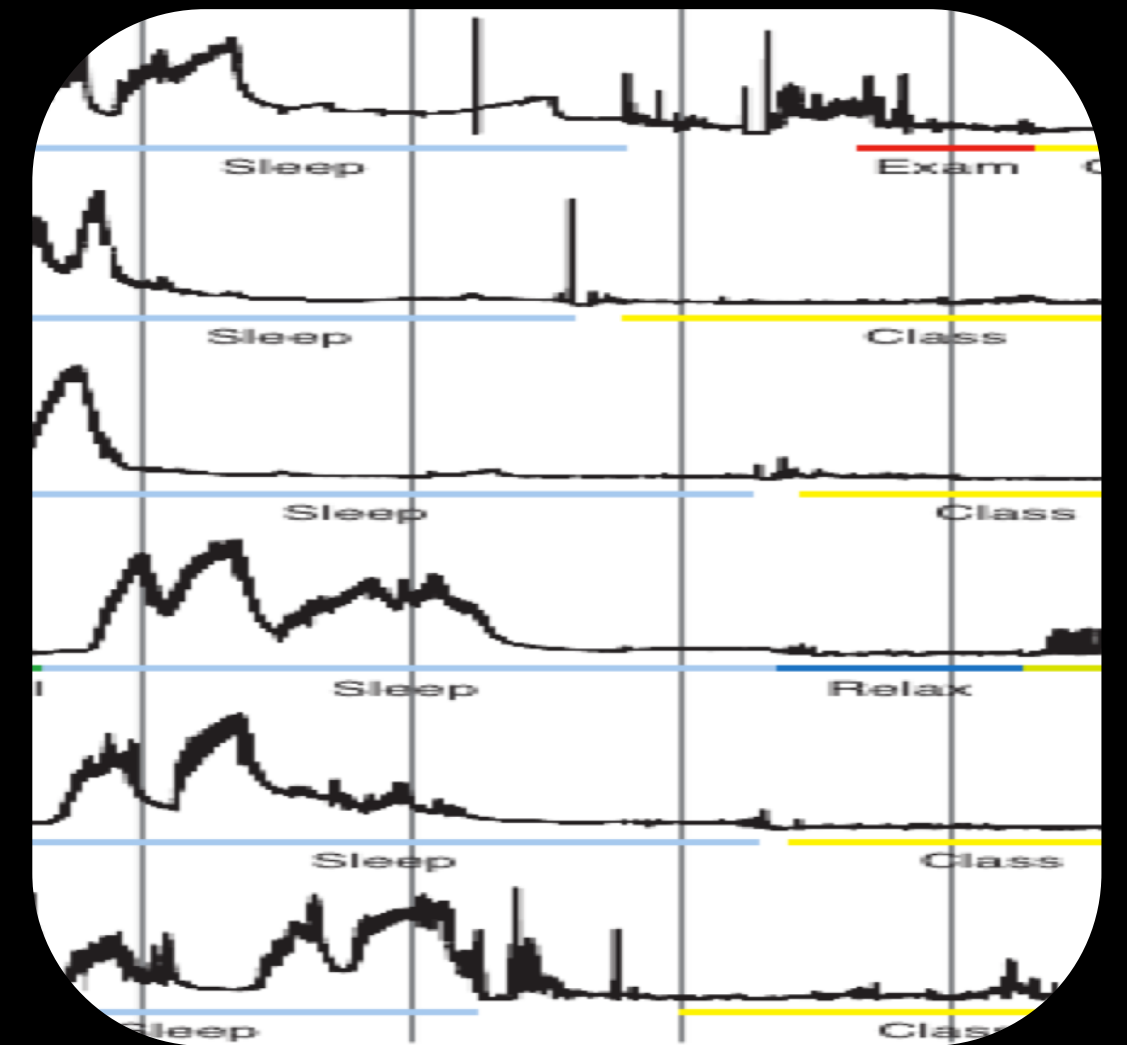
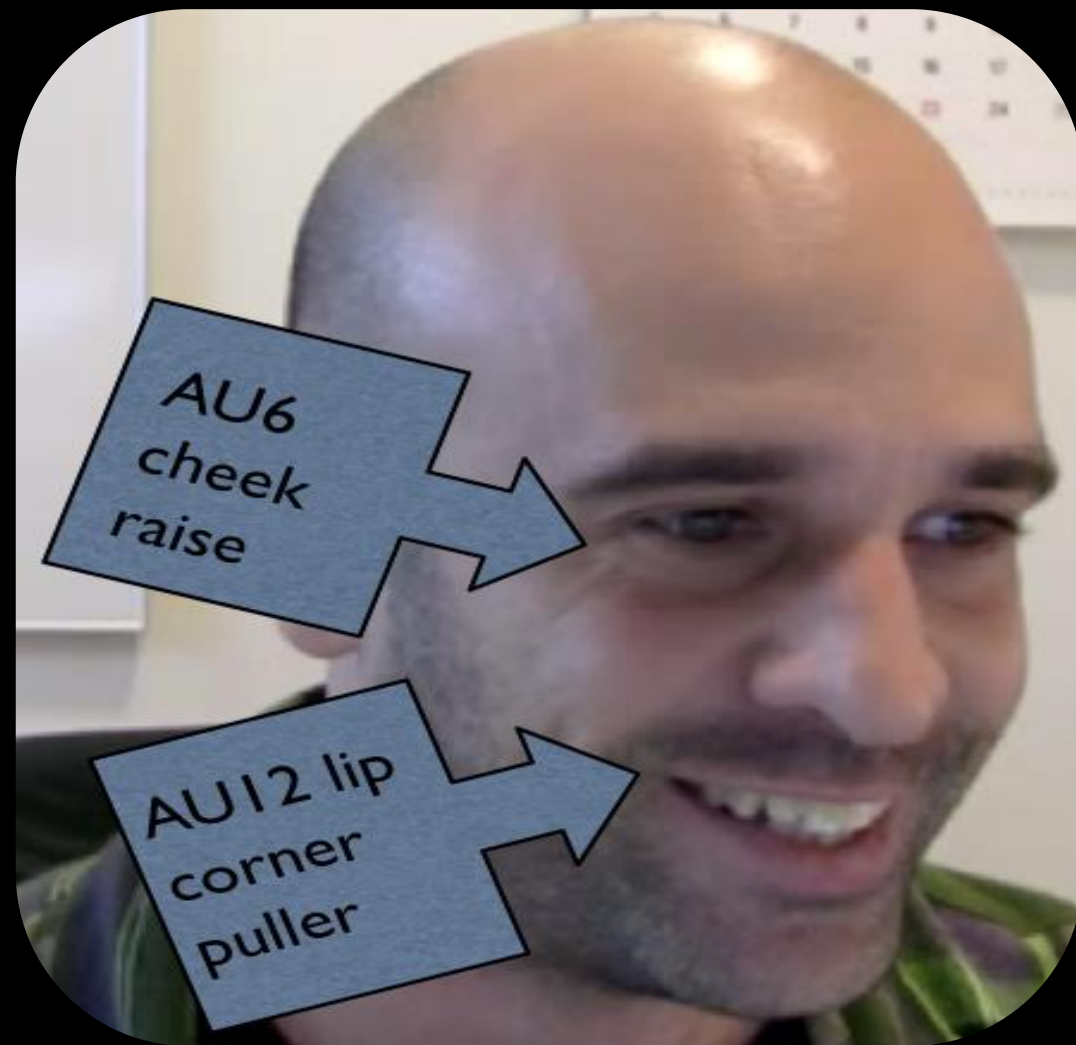
Do big good

**Where will your
future work aim
?**

**Hard enough
to earn a PhD**

Super hard

Do little good



Free publications: affect.media.mit.edu
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