

How do you figure out *what is painful or distressing to a non-speaking person?*

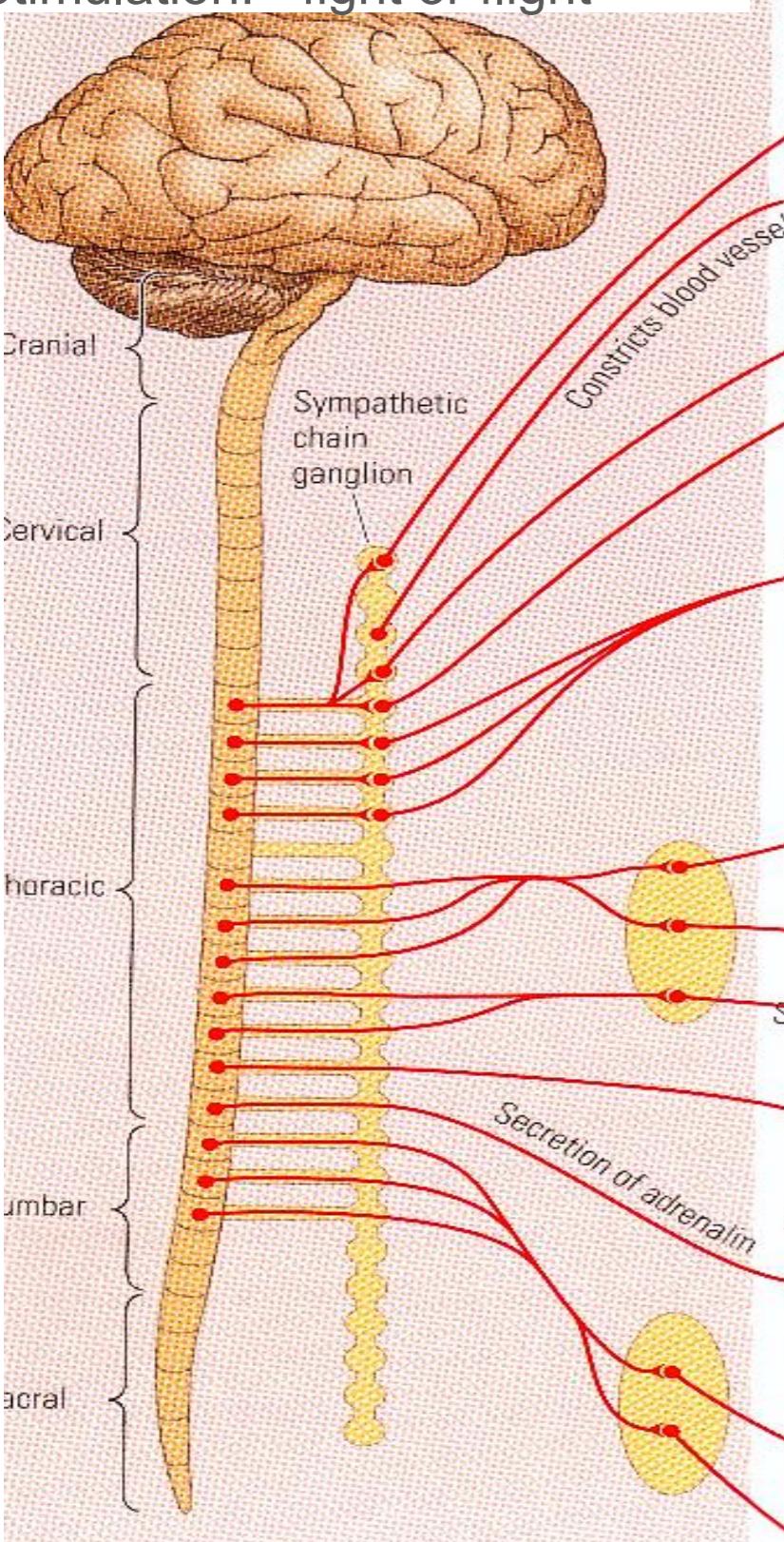


Many do not show outward signs consistent with internal stress/state.

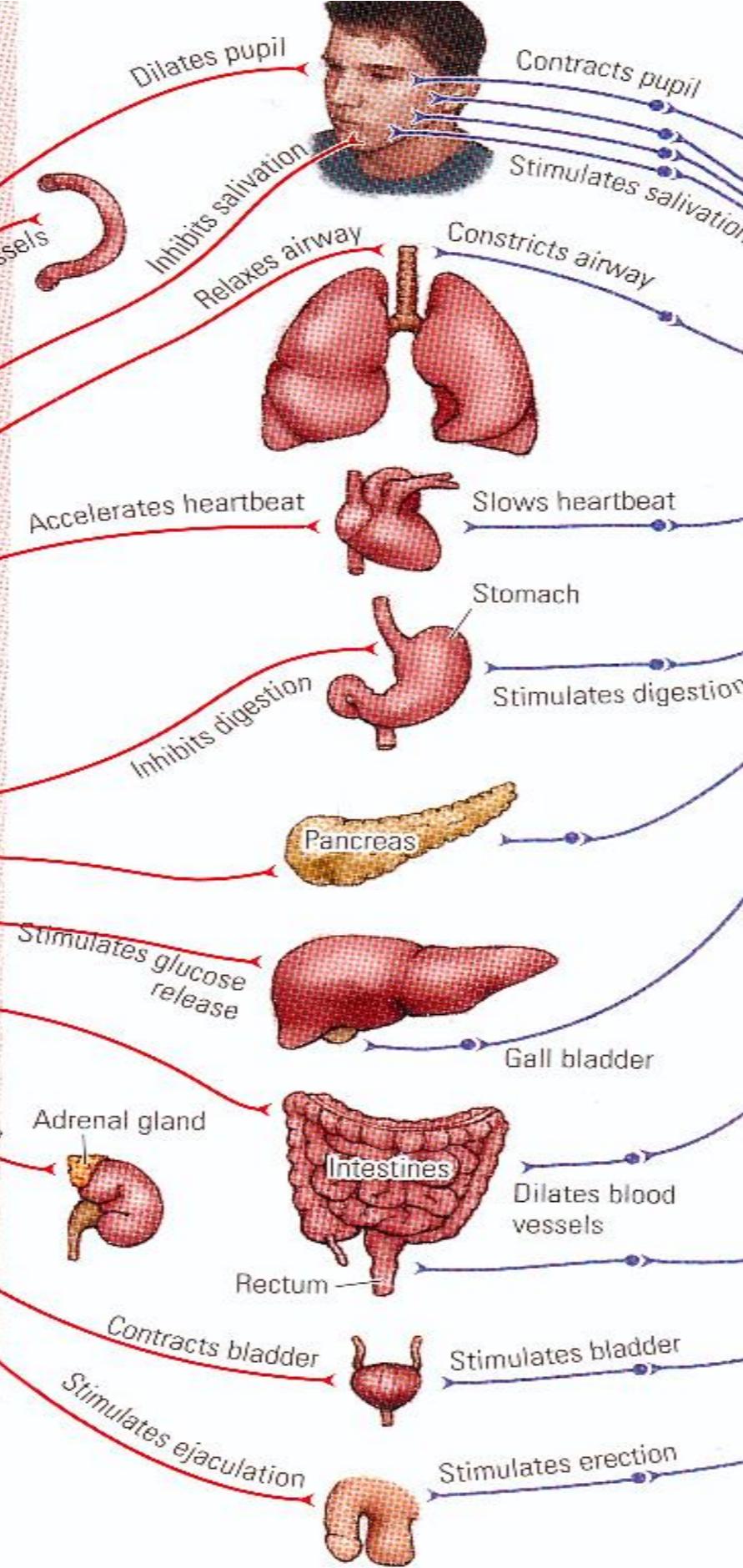
Image courtesy of [John Glenn](#) on flickr. License CC BY-NC-SA.

Sympathetic division

Stimulation: “fight or flight”

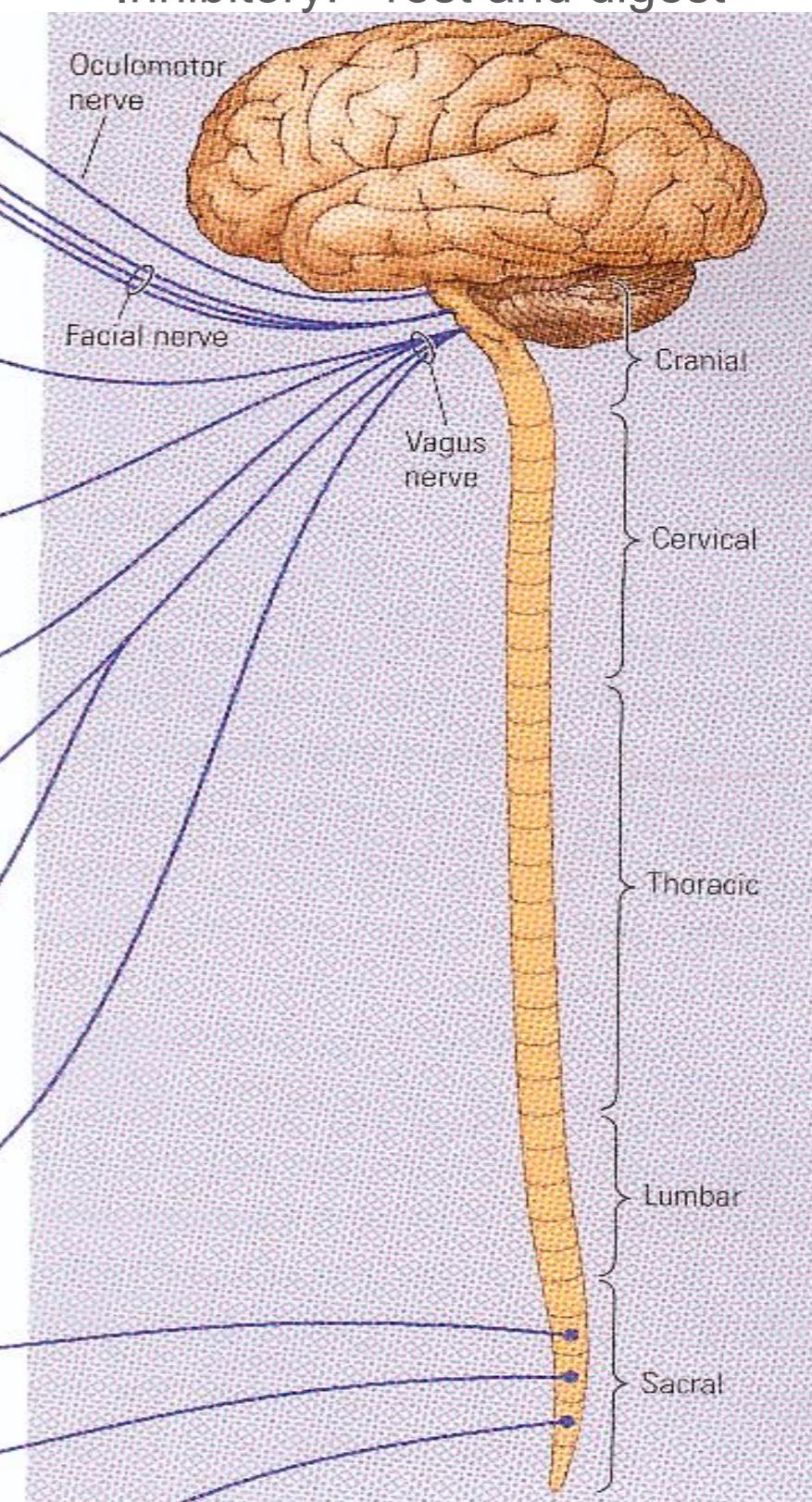


AUTONOMIC NERVOUS SYSTEM



Parasympathetic division

Inhibitory: “rest and digest”



(Not shown: Enteric division)

Electrodermal Activity (EDA) Sensors



Traditional

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MIT Media Lab
Innovations

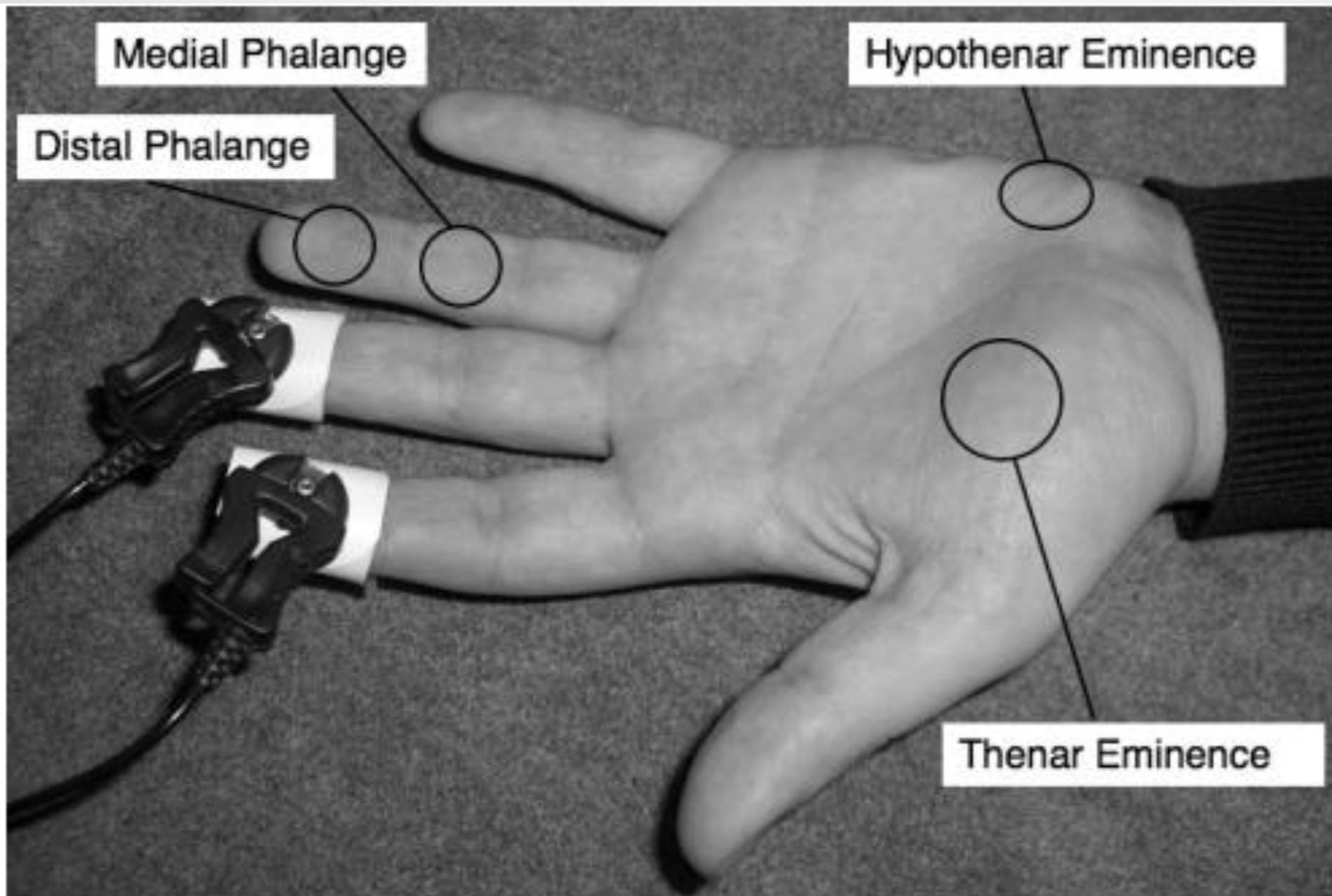


Affectiva Q™

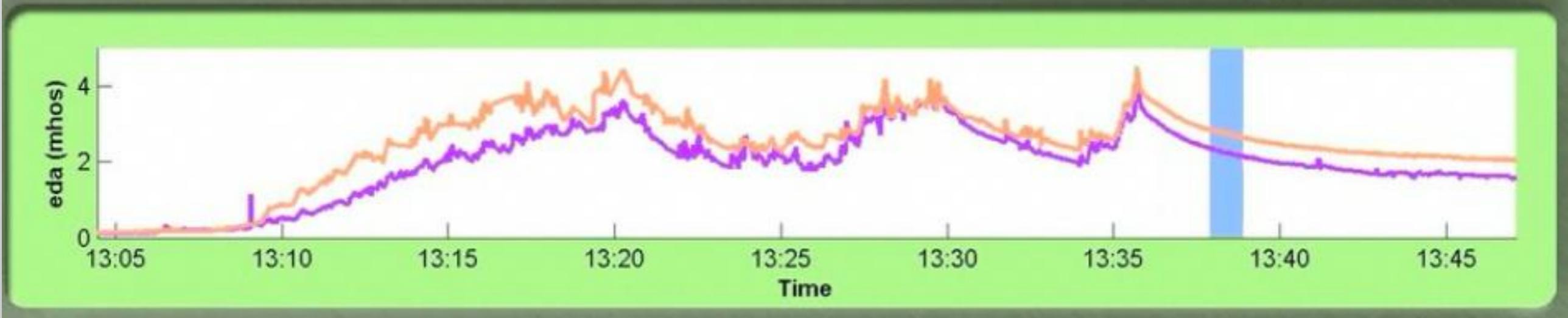
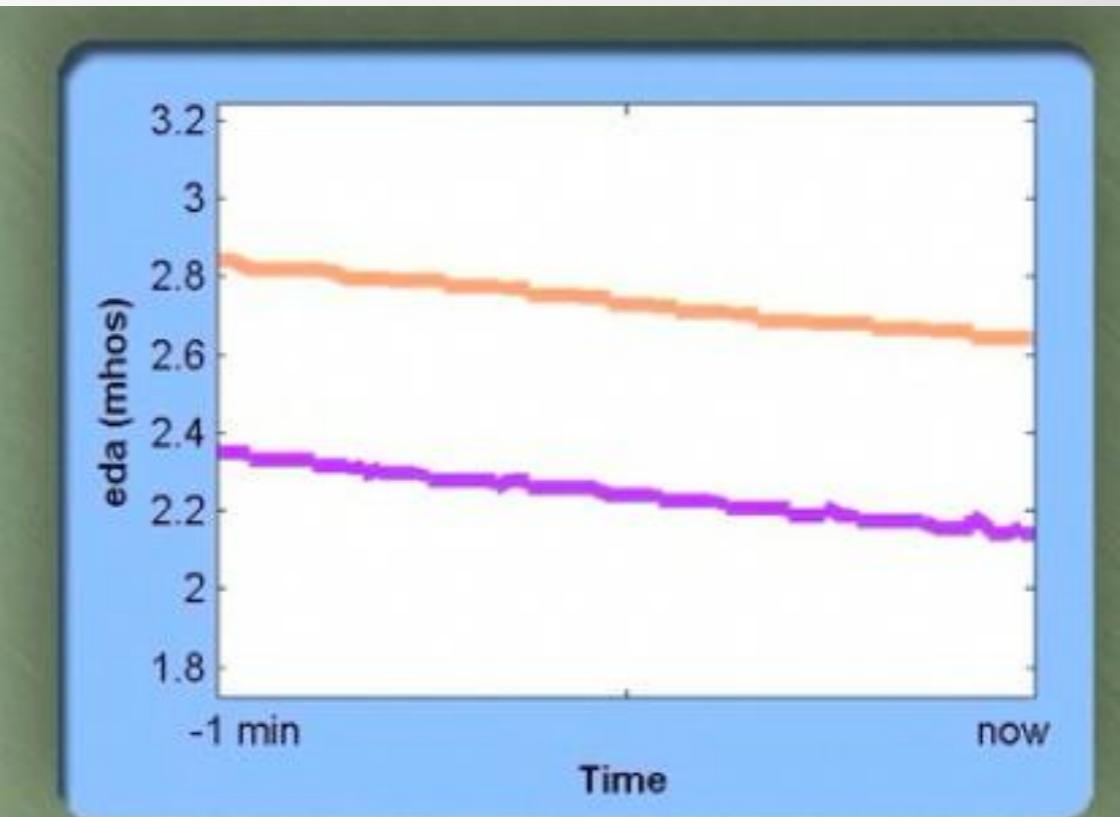
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Typical placement skin conductance electrodes (figure 4 from Figner-Murphy)



Example: Measuring sympathetic nervous system response via electrodermal activity (EDA) on lower legs



Arousal predicts memory and attention



What makes EDA go up? | Demo

EDA = Electrodermal Activity

(measured as skin conductance)



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Affectiva Q Sensor measures:

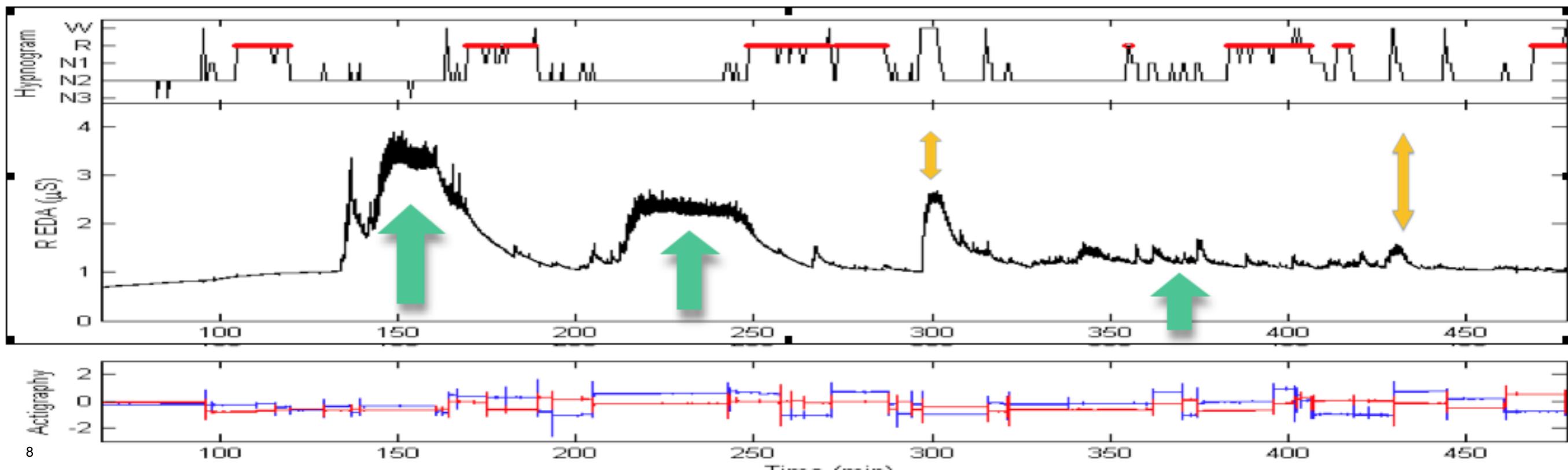
- 1. Skin conductance**
- 2. Skin temperature**
- 3. 3-axis accelerometer**

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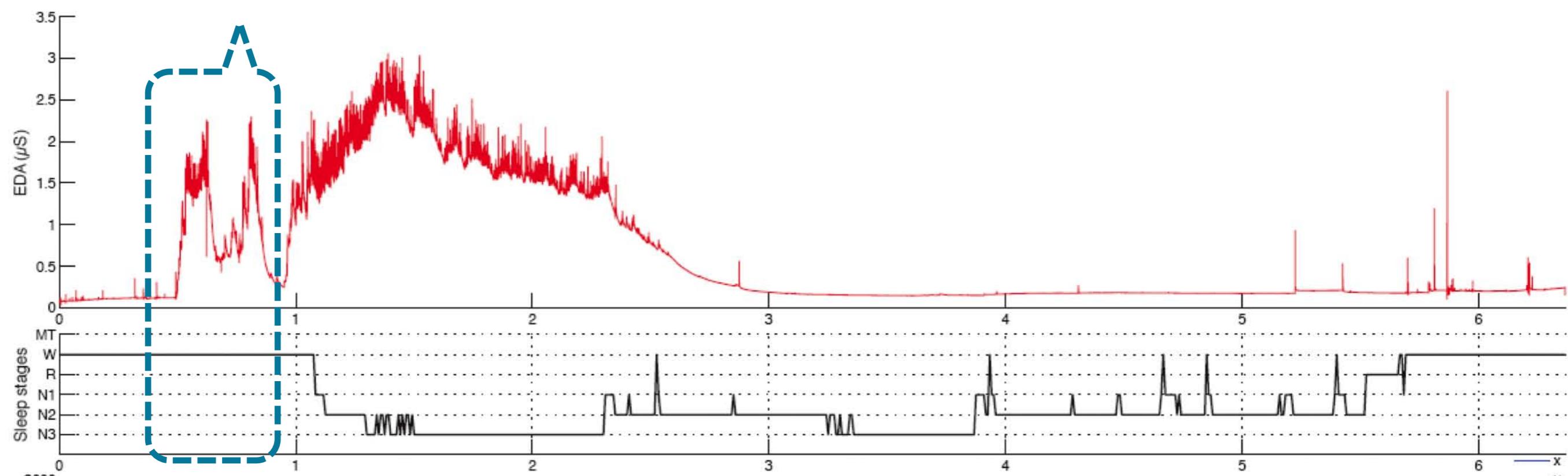
State of the art:

- Built sensor & algorithms
- Detects “peak storms” (92% in Non-REM)
- Measuring connections to learning & memory & stress

(Sano & Picard; MIT, EMBC 2011, collaborations with Bob Stickgold, Harvard & Beth Israel hospital, Chuck Czeisler, Harvard & Brigham & Women's hospital)

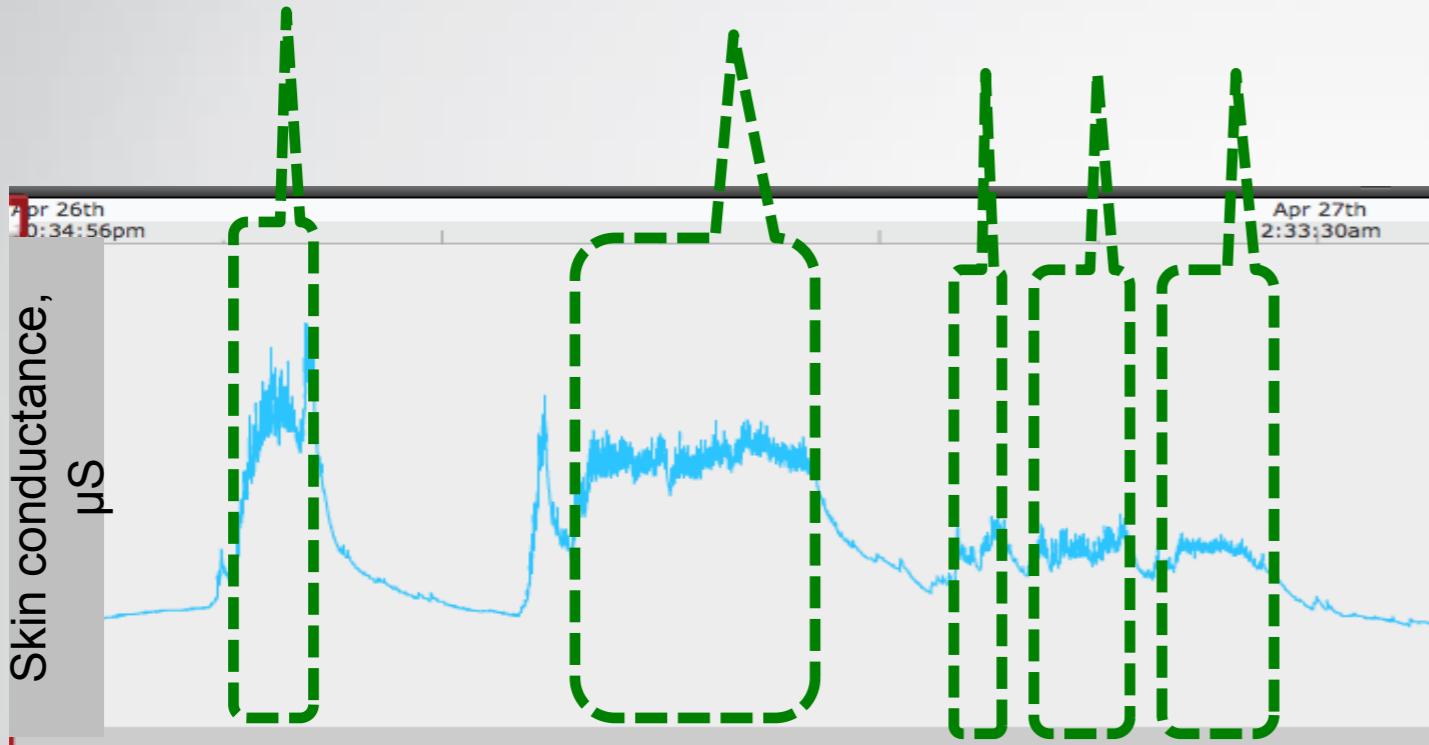


arousals picked up
by wristband while
trying to fall asleep



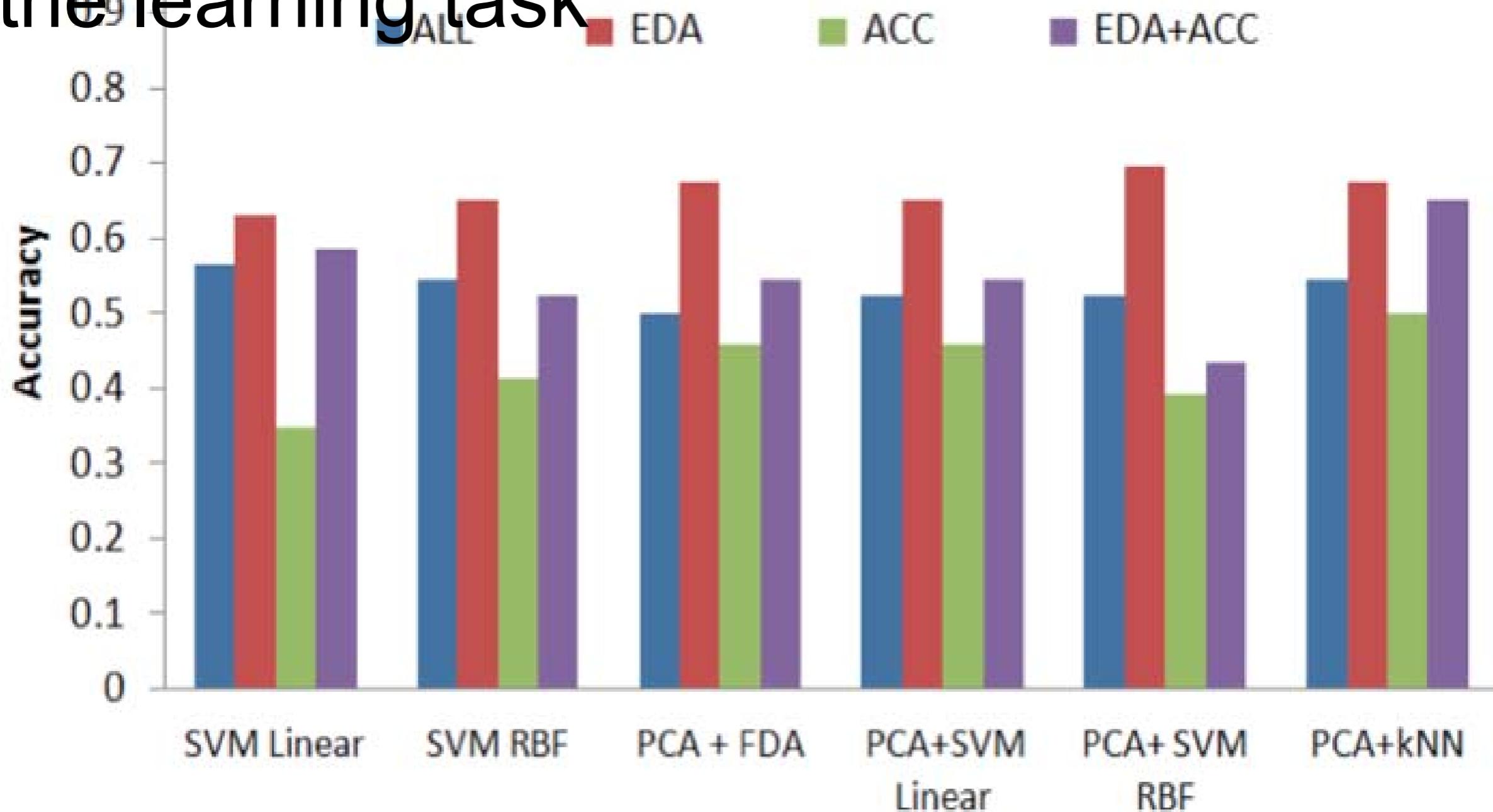
EDA arousals relate to quality of sleep in Autism Spectrum Disorders Sano, Picard, el Kaliouby, Malow, Goldman, IMFAR 2011.

EDA “Storms” during sleep



Investigating relation to sleep quality and to improvement
on a visual discrimination task
Sano, Picard, Wang, Stickgold, APSS 2011.

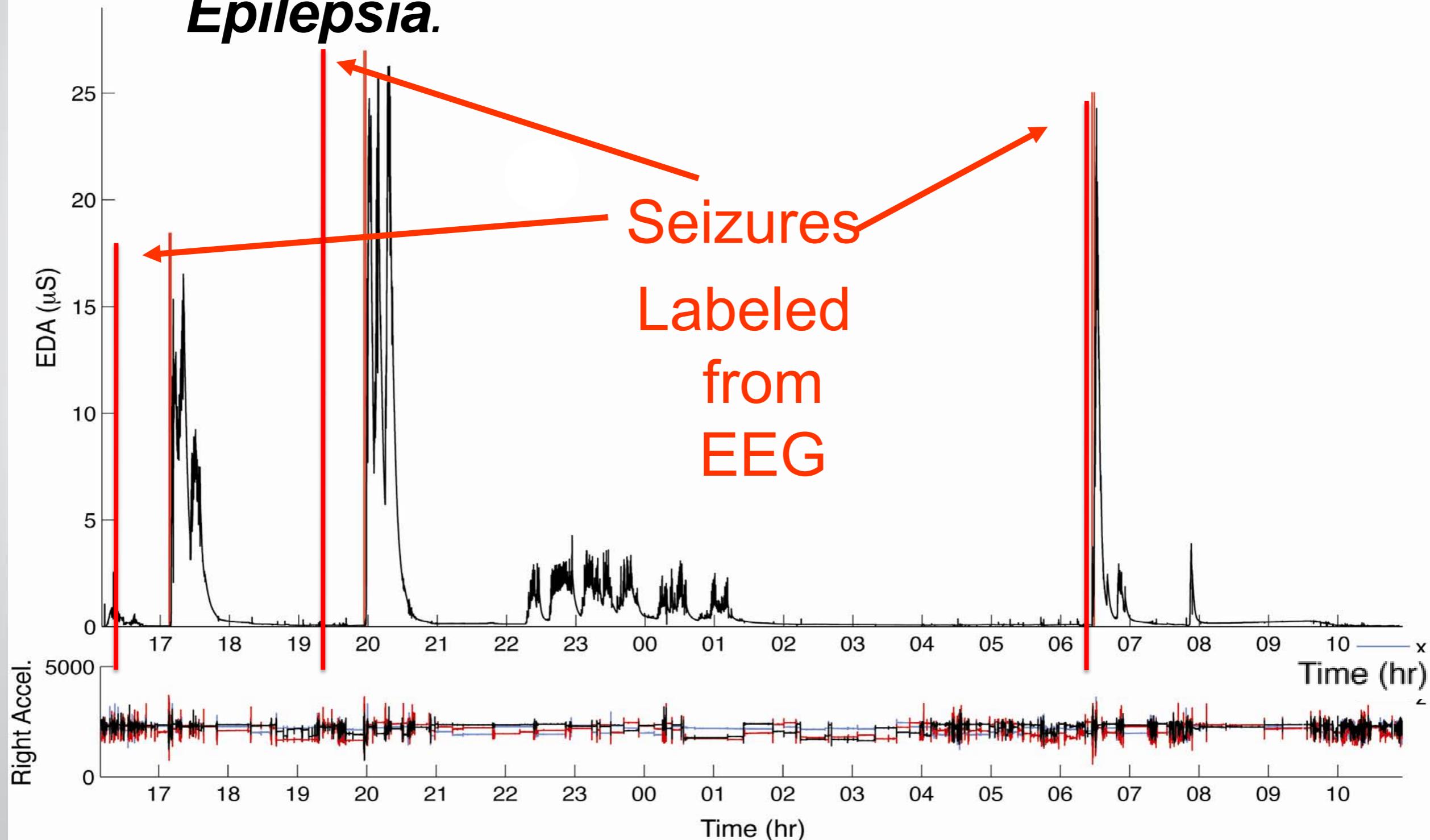
EDA gives the highest accuracy
determining who improved the most on
the learning task



Sano A., Picard R.W., "Recognition of Sleep Dependent Memory Consolidation with Multi-modal Sensor Data", The 10th Annual Body Sensor Networks Conference 2013, Cambridge, USA, May 2013

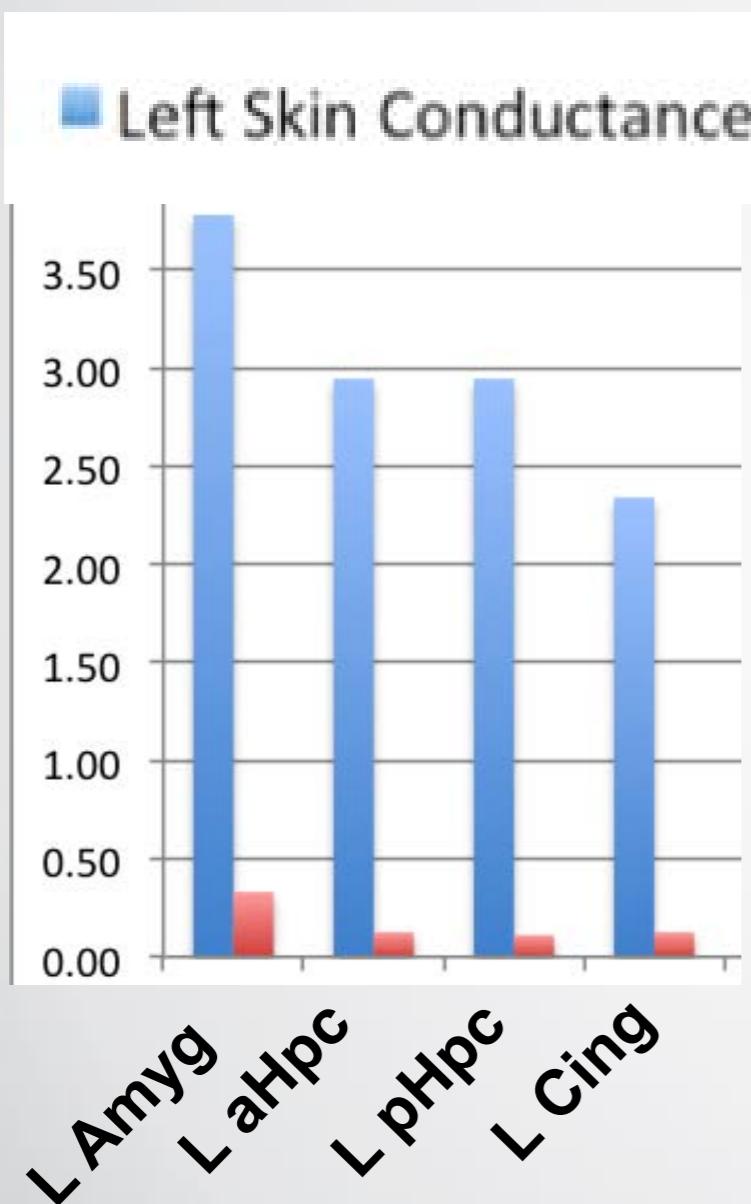
94% accurate convulsive seizure detection using a wrist-worn electrodermal activity and accelerometry biosensor. Poh et al (2012),

Epilepsia.

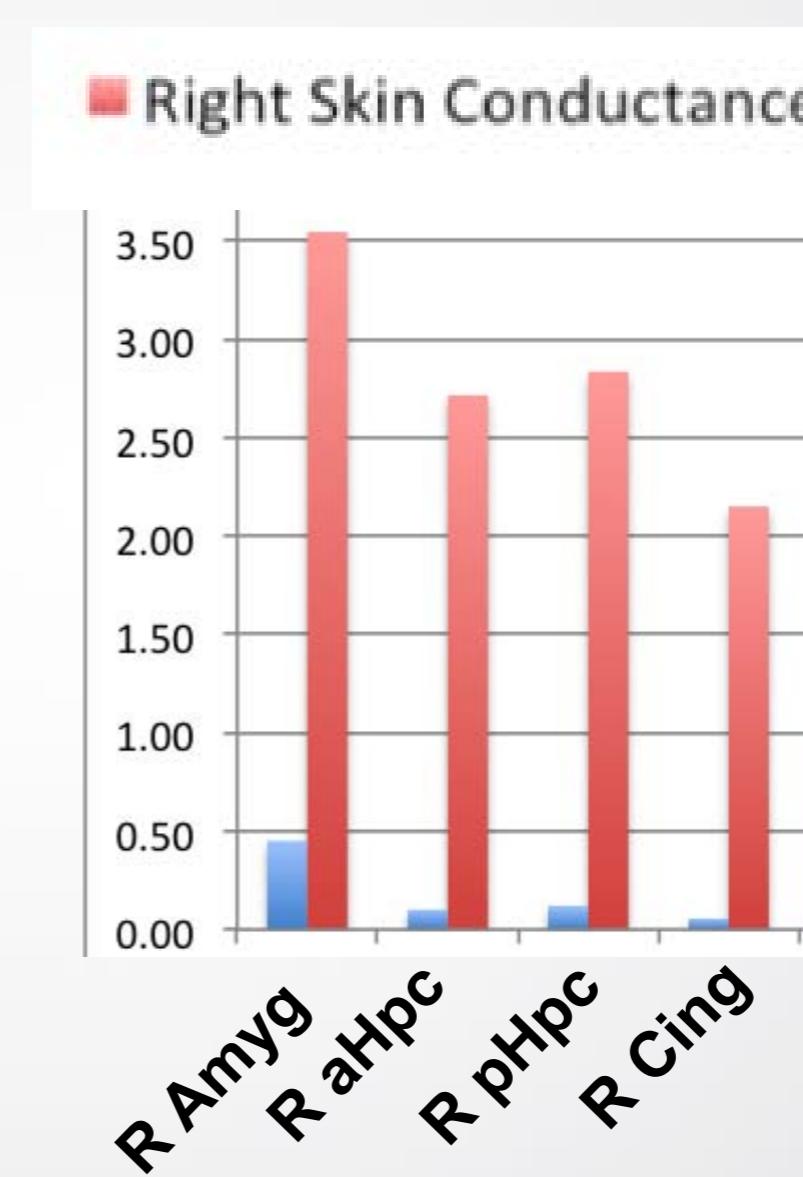


Canadian Epilepsy Alliance video: Playground Convulsive Seizure

Stimulation on brain's left side



Stimulation on brain's right side

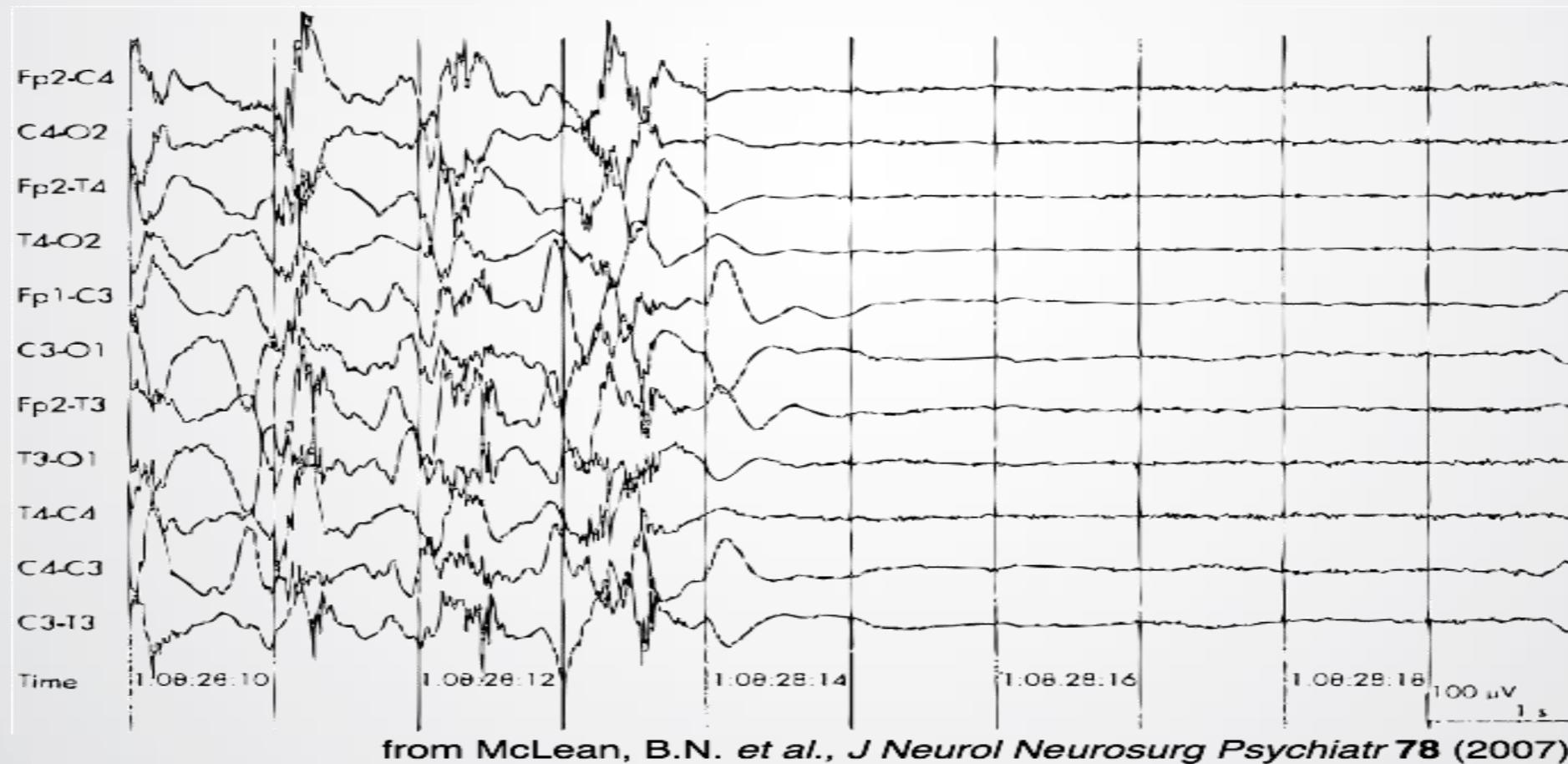


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Mangina & Beuzeron-Mangina 1996, Int. J. Psychophysiology 22(1996) 1-8.

Sudden Unexplained Death in Epilepsy (SUDEP)

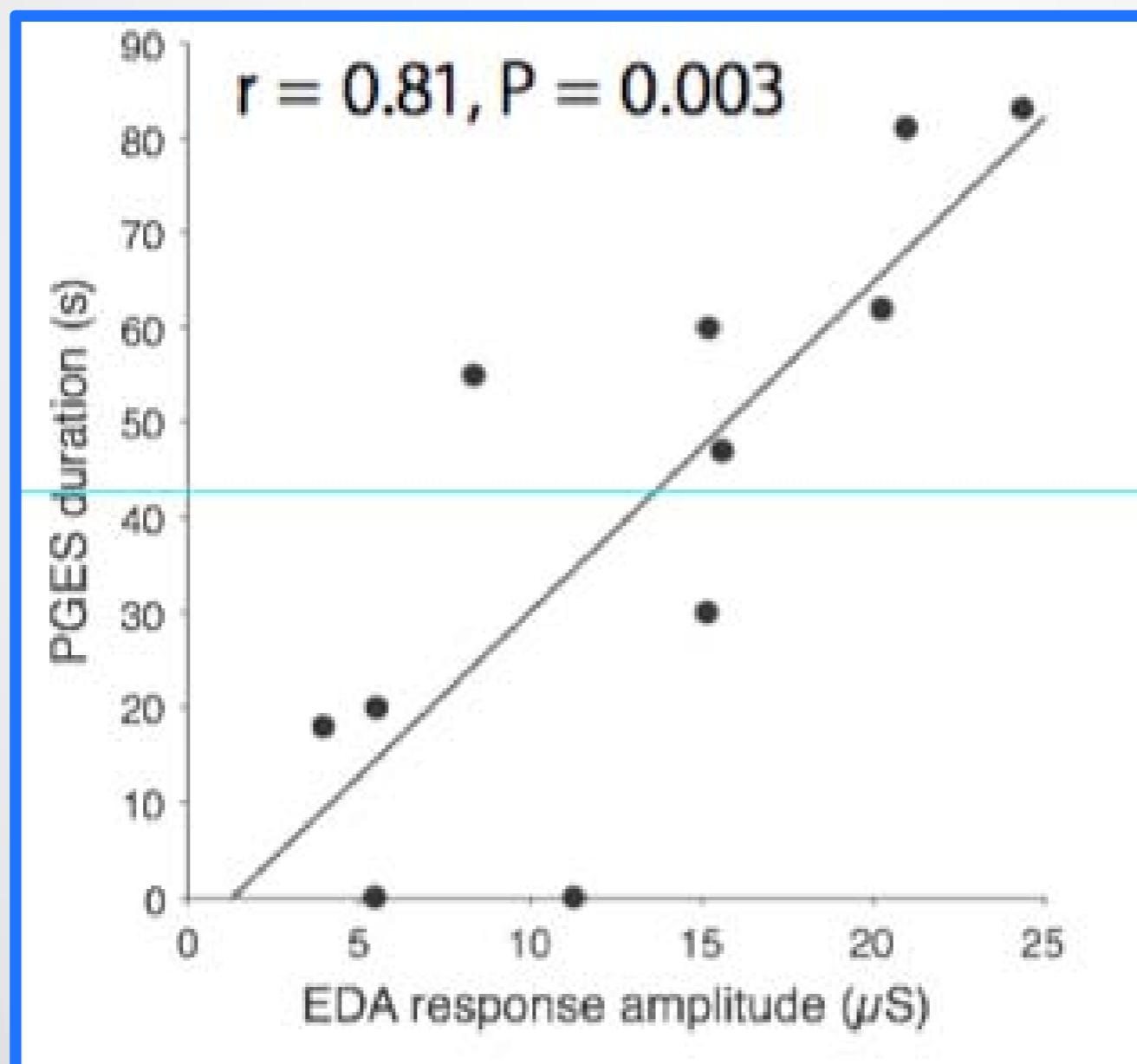
Post-ictal EEG Suppression:
Possible biomarker for SUDEP risk



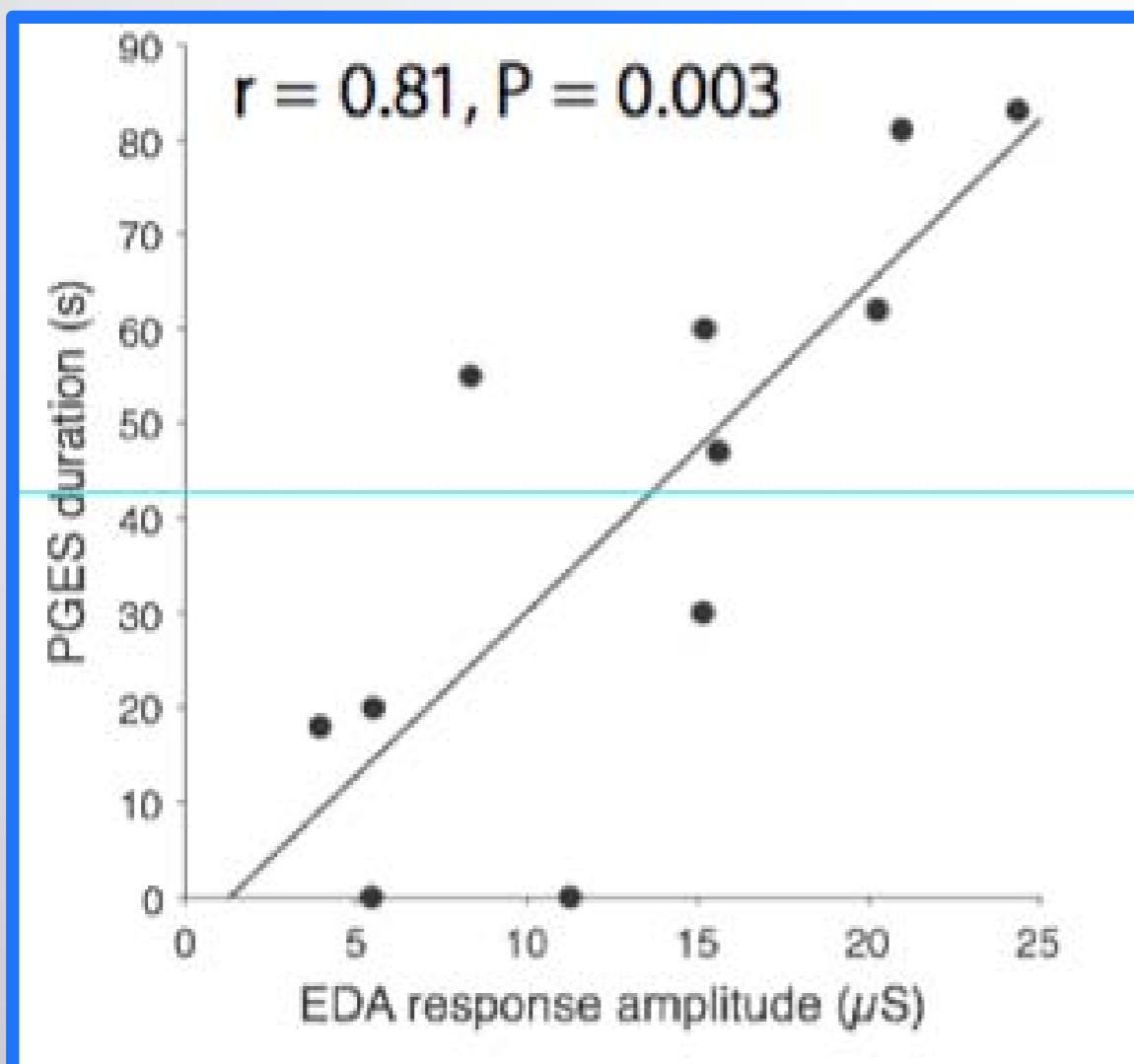
Lhatoo, S.D. et al., Ann Neurol 68 (2010)

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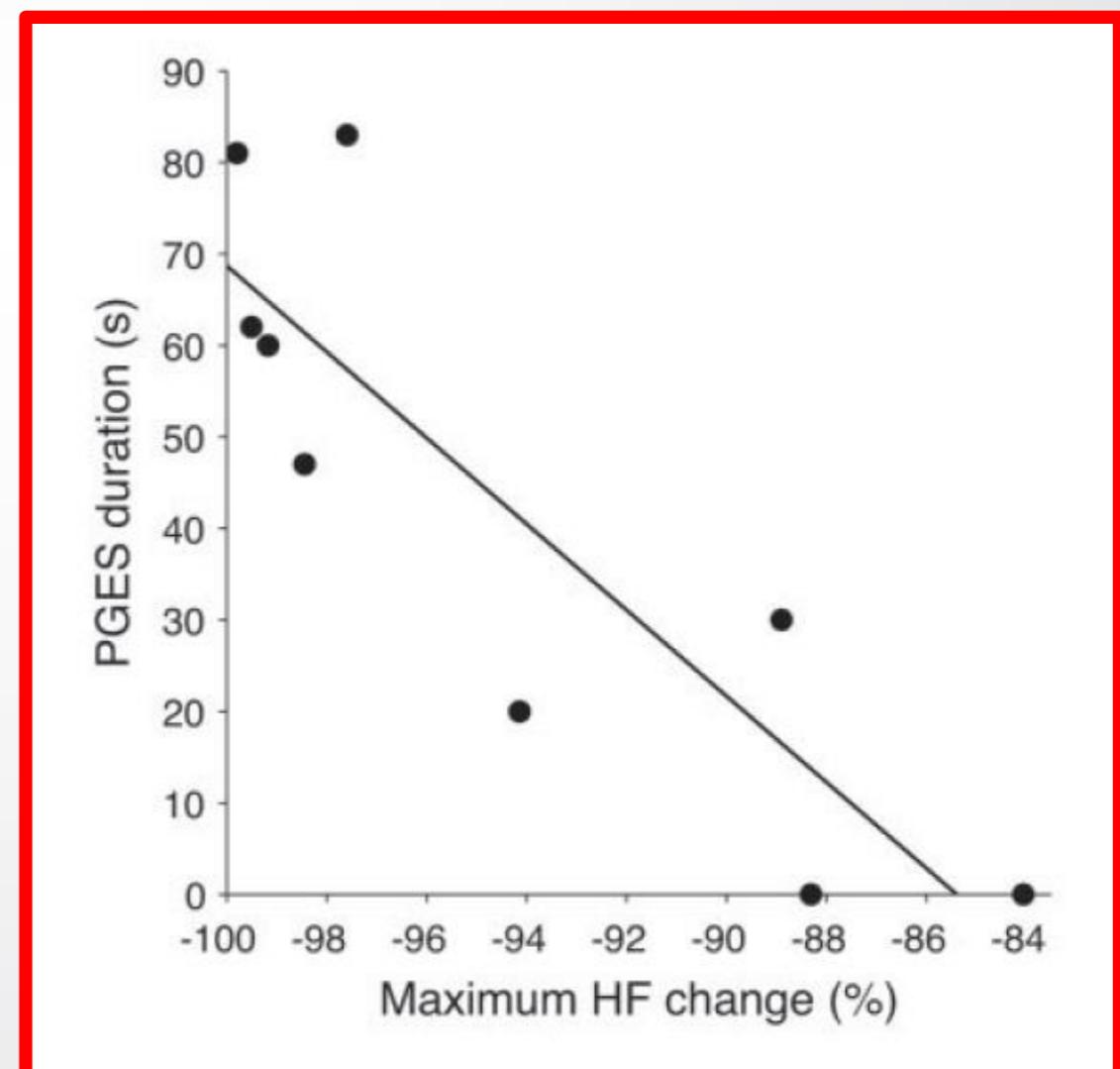
Autonomic response (from wrist) is correlated with duration of EEG suppression (SUDEP biomarker)



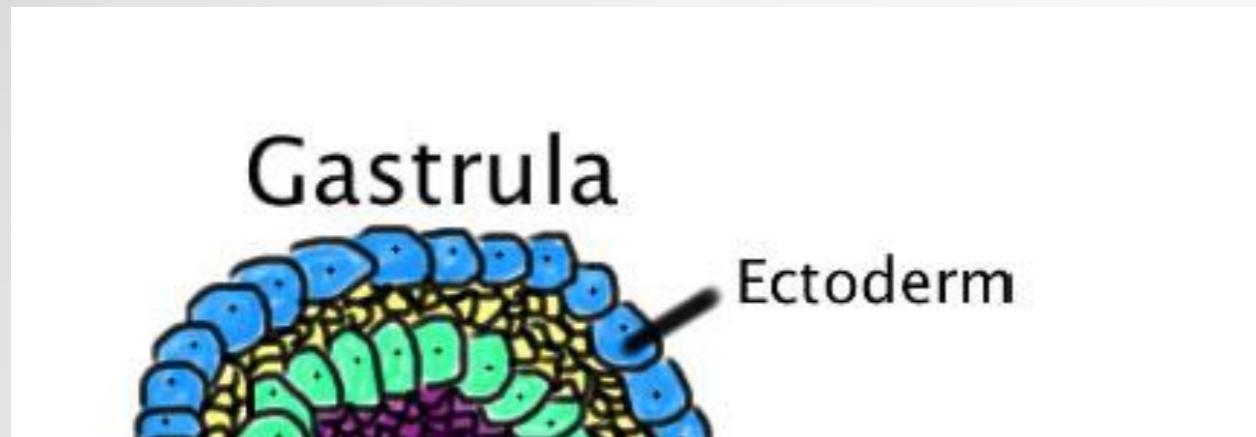
Larger Sympathetic (EDA) occurs with longer post-ictal EEG suppression (PGES)



Lower Parasympathetic (Heart Rate Variability High Frequency) occurs with longer PGES



Human Embryo: Three tissue layers



This [image](#) is in the public domain.

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

Why look at both left and right EDA, separately?

Right amygdala is associated with threat/negative stimuli

Left amygdala is associated with a mix of positive and negative arousal.

Ji G, Neugebauer V. (2009) "Hemispheric lateralization of pain processing by amygdala neurons" *J Neurophysiol.* 2009 Oct;102(4):2253-64. Epub 2009 Jul 22

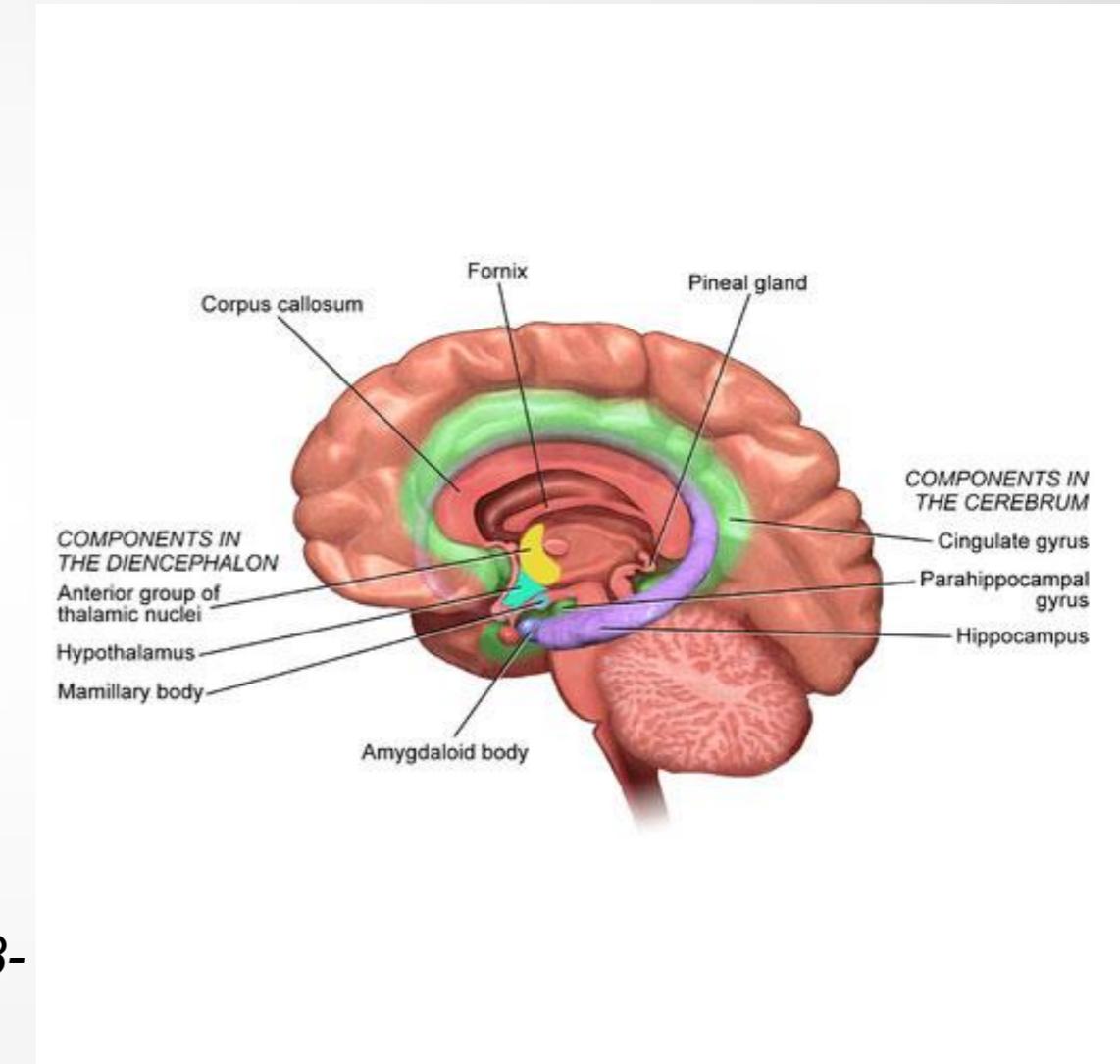
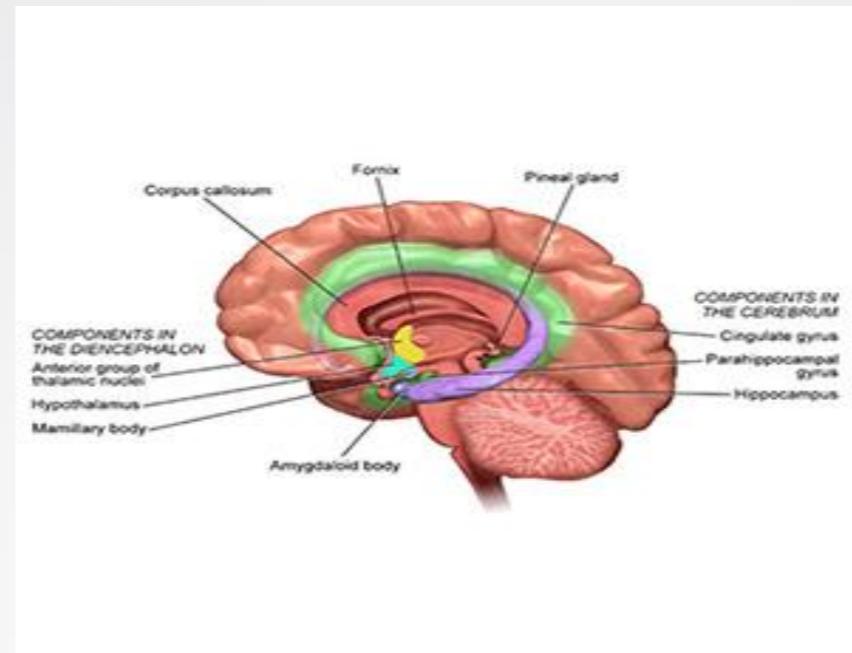


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Why look at left and right EDA?

Left amygdala activates EDA on Left wrist



Right amygdala activates EDA on Right wrist

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Skin conductance (sympathetic nervous response) is ipsilateral to these limbic brain structures

Amygdala
Posterior hippocampus
Anterior hippocampus
Anterior cingulate gyri

References

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