Electrodermal Activity for Emotions Research Overview

Idalis Villanueva, Ph.D.

SCIPIE Conference, Las Vegas

October 20, 2017
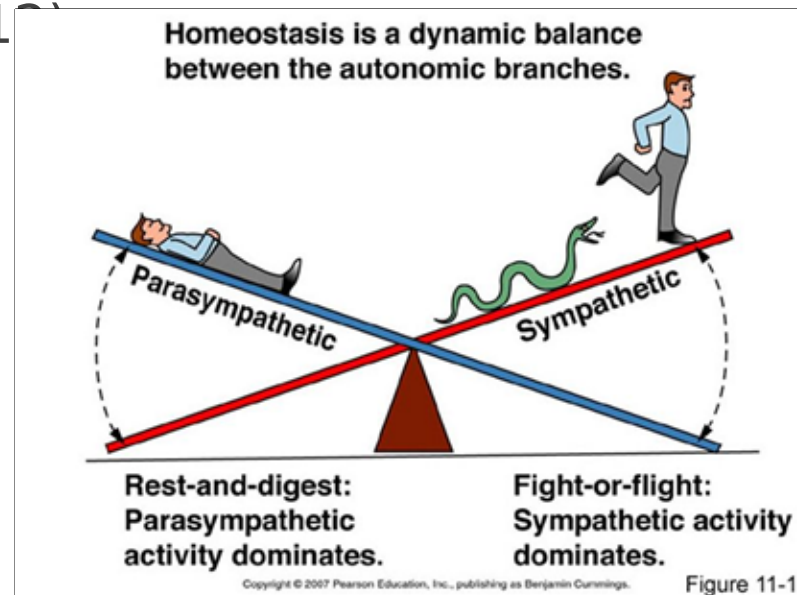
Brief Introduction to Autonomic Nervous System (ANS)

Within the ANS, two nervous systems serve different functions:

Parasympathetic nervous system (PNS) functions to maintain balance and rest to the body (i.e., rest and digest)

Sympathetic nervous system (SNS) controls the body's responses to perceived threat (i.e., fight or flight).

Most existing measures today rely on **SNS** due to its **direct link** to the ANS system without potential interference from other nervous systems (e.g., somatic) (Bouscein, 2012)

Homeostasis is a dynamic balance between the autonomic branches.

Parasympathetic

Sympathetic

Rest-and-digest: Parasympathetic activity dominates.

Fight-or-flight: Sympathetic activity dominates.

Copyright © 2007 Pearson Education, Inc., publishing as Benjamin Cummings
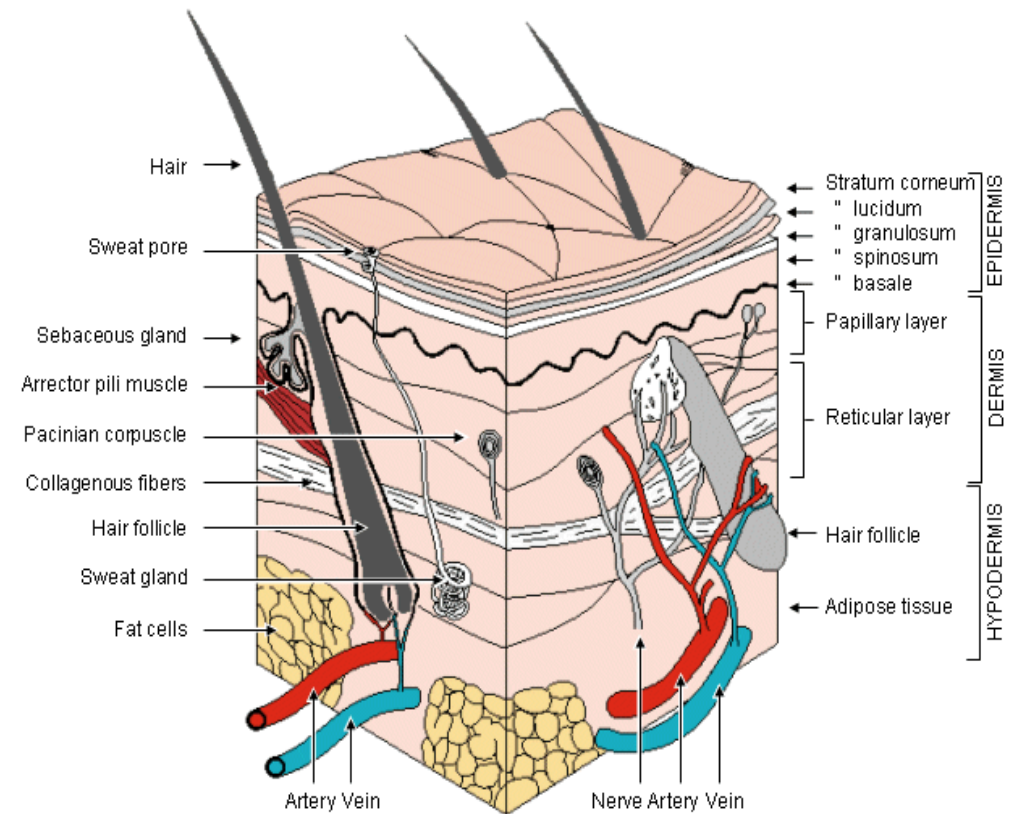
Figure 11-1

Physiology of Skin Conductance

Electrodermal activity (EDA) is widely considered as a proxy for quantifying stress level or cognitive load in the SNS via skin conductance.

However, the corneum contains simple tubes (or ducts) that are made up by these cells on the skin surface. As these ducts fill, sweat becomes a good conductor, reducing the resistance present in the skin.

Affective and cognitive processes, among other brain functions, can influence the control of sweating.

More activation of the Autonomic Nervous System (e.g., high cognitive load or strong emotional responses) results in more sweat compared to low activation states (e.g., low cognitive load).

EDA is typically measured in locations where sweat glands are most dense (e.g., fingers) and whose region contains a greater number of innervated fibers

Electrodermal Activity: Indicative of Arousal

- Affective and cognitive processes, among other brain functions, can influence the control of sweating.

- When a person becomes nervous or anxious about a task, their palms become sweaty.

- Electrodermal activity (EDA) is widely considered as a proxy for quantifying stress level or cognitive load in the SNS.

  - Typically measured in locations where sweat glands are most dense (e.g., fingers) and whose region contains a greater number of innervated fibers
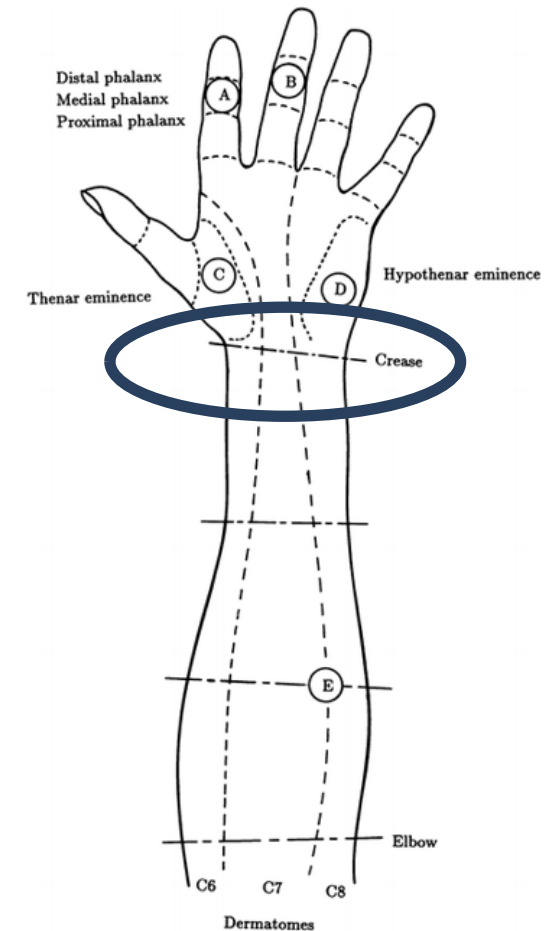
Electrodermal Measures

Two major measures of the electrodermal response:

1. Resistance or conductance between two electrodes placed in the palmar region. This type of measurement is referred to as *exosomatic*, since the current on which the measurement is based is introduced from the outside.

2. The second type, which is less commonly used, is called *endosomatic*, since the source of voltage is internal.

Researchers also distinguish whether the measurement is of the (**tonic**) background level (L), or the time-varying (**phasic**) response (R) type.

Examples of Electrodermal Measures

EDA   (Electrodermal Activity)
EDL   (Electrodermal Level)
EDR   (Electrodermal Response)
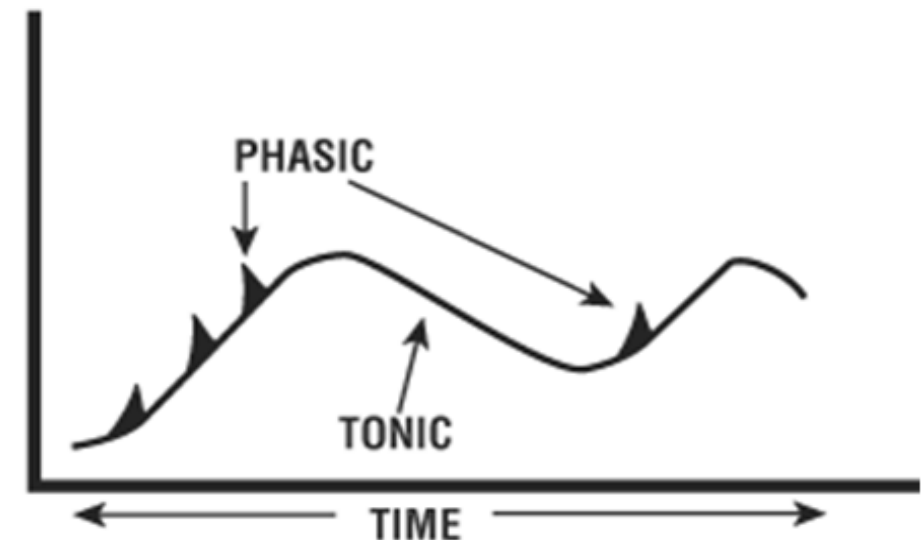
Affective/Physiological Processes

Transactional Model by Lazarus and Folkman, 1984) states that cognitive processes of appraisal are central in determining whether a situation is potentially harmful

- Primarily based on appraisal and affect models

- Research suggests that the perception of how stressful a task or problem is dependent on the realization that one has either more or less than adequate resources to deal with the problem (Folkman, 2001)

- Among students, research indicates that the occurrence of positive or negative affect is tied to autonomic responses (Heponiemi, Ravaja, Elovainio, Naatanen, & Keltikangas-Jarvinen, 2006; Renwick, Vosvick, & Chng, 2008)

Valence-Activation Circumplex Model (Bouscein, 2012; Christie & Friedman, 2004; Van Dooren, 1997) that suggests a 2-D structure found in many valence/activation models
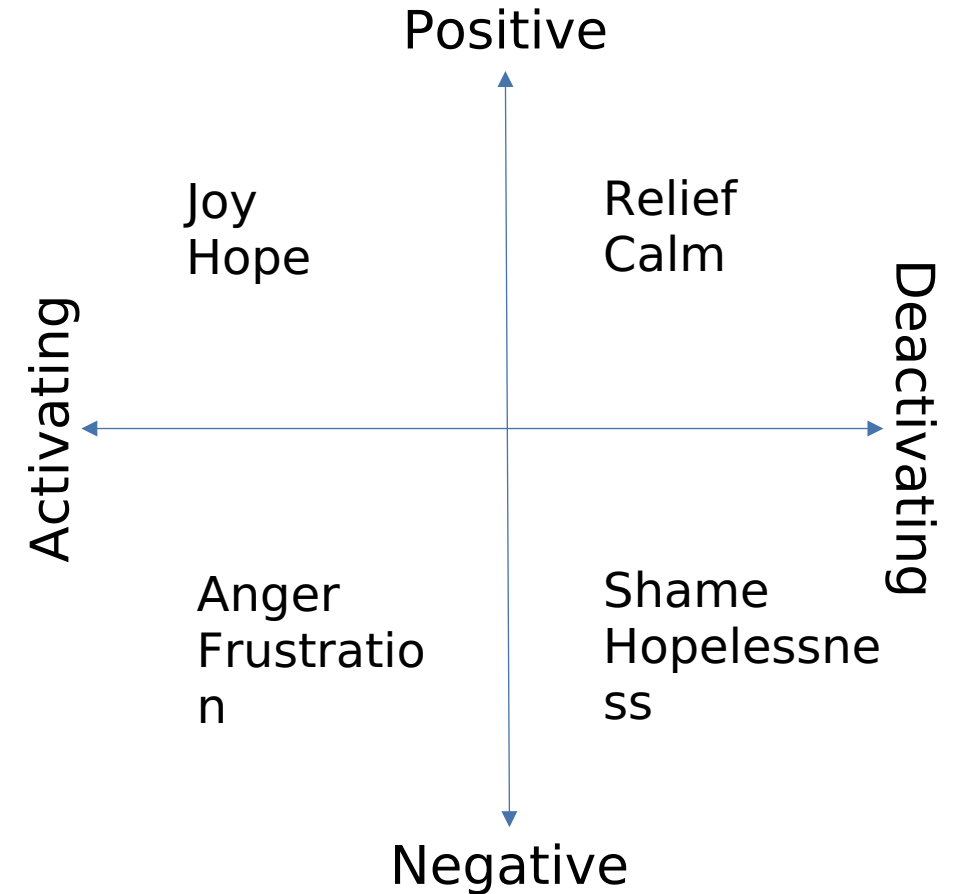
Affective/Physiological Processes

Pekrun suggests as a "multi-component, coordinated processes of psychological subsystems including affective, cognitive, motivational, expressive, and peripheral physiological processes" (Pekrun, 2006 p. 316)
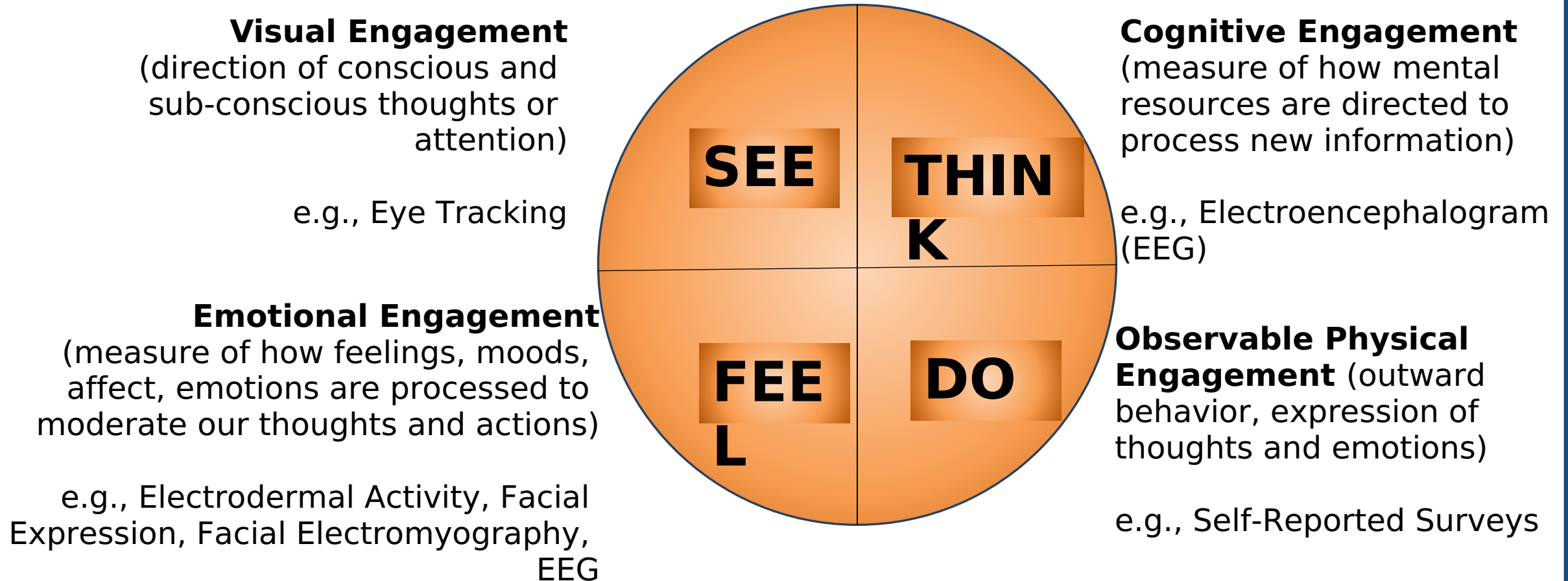
Valence (Positive/Negative)

Activation (Activating/Deactivating)

There are also limited studies trying to tease out potential associations between the multi-component processes

For EDA, the challenge is to differentiate between positive/negative and activating/deactivating

Positive

Joy
Hope

Relief
Calm

Activating

Deactivating

Anger
Frustration

Shame
Hopelessness

Negative

Multi-Modal Approaches Needed for EDA

Visual Engagement
(direction of conscious and sub-conscious thoughts or attention)

e.g., Eye Tracking

Cognitive Engagement
(measure of how mental resources are directed to process new information)

e.g., Electroencephalogram (EEG)

Emotional Engagement
(measure of how feelings, moods, affect, emotions are processed to moderate our thoughts and actions)

e.g., Electrodermal Activity, Facial Expression, Facial Electromyography, EEG

Observable Physical Engagement (outward behavior, expression of thoughts and emotions)

e.g., Self-Reported Surveys

SEE THINK FEEL DO

*** All require the combination of multiple modes of collection to minimize bias and ensure proper validity and reliability of findings ***

Data Collection Considerations

Empatica, E4 sensor

iMotions (Shimmer)

Baseline

To collect EDA, you must provide a time period where tonic and phasic responses are similar

Participants should be engaged in no activating cognitive activities

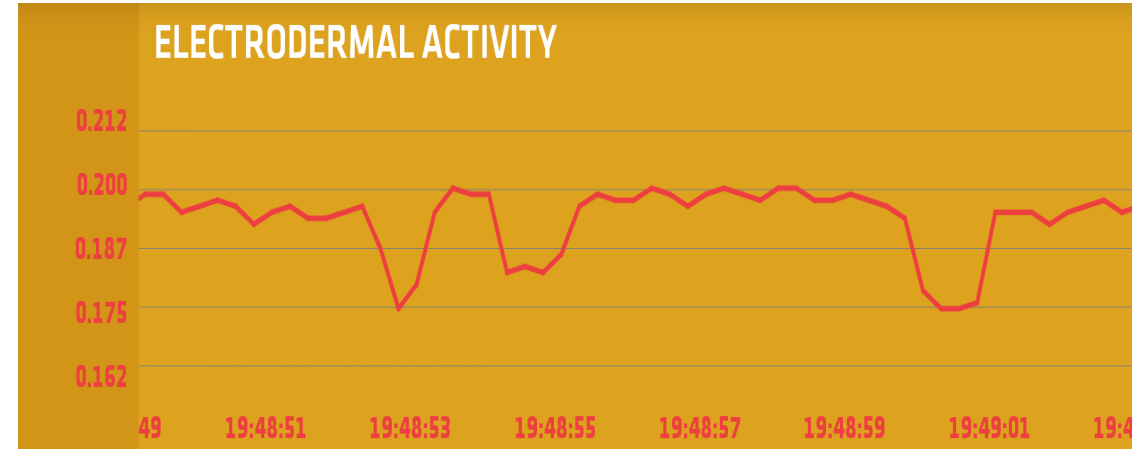Typical baseline times range from 3 -5 minutes at the beginning of a session

Recovery

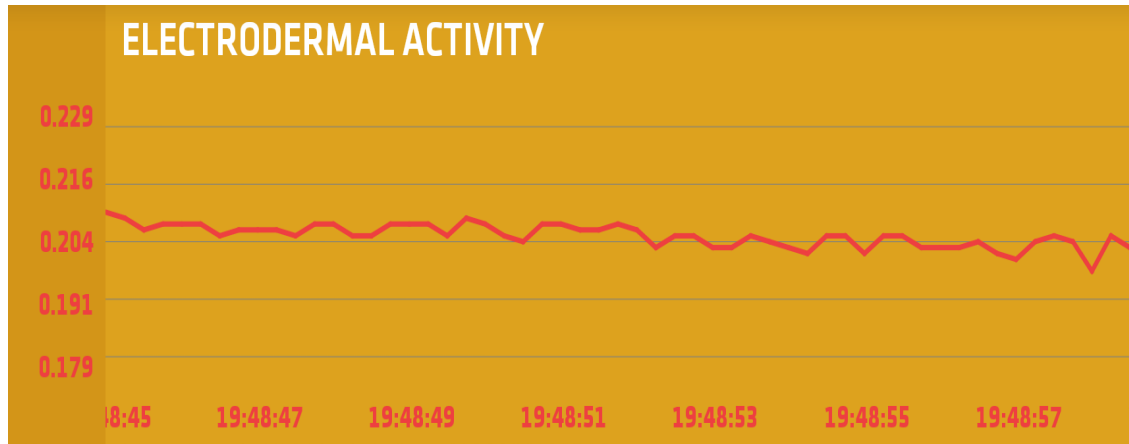To ensure EDA response is due to a particular event, you must allow periods of pause between events
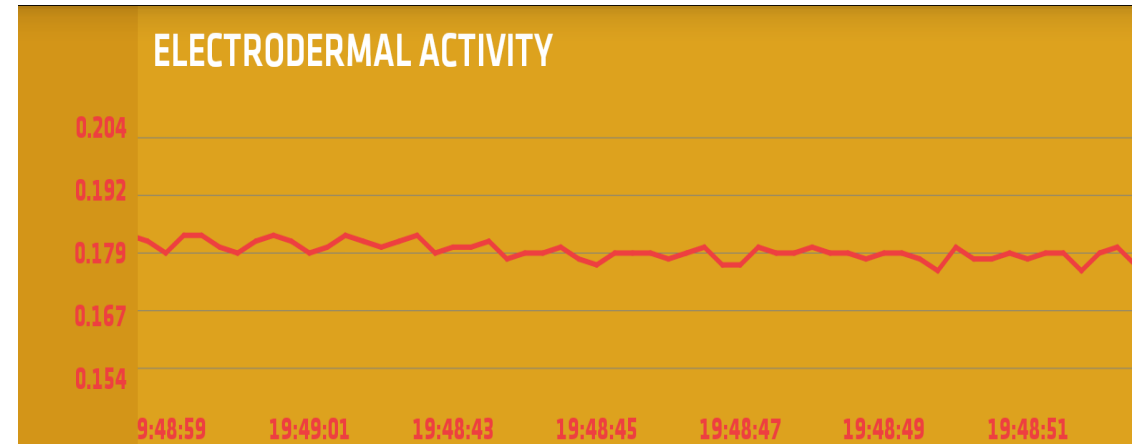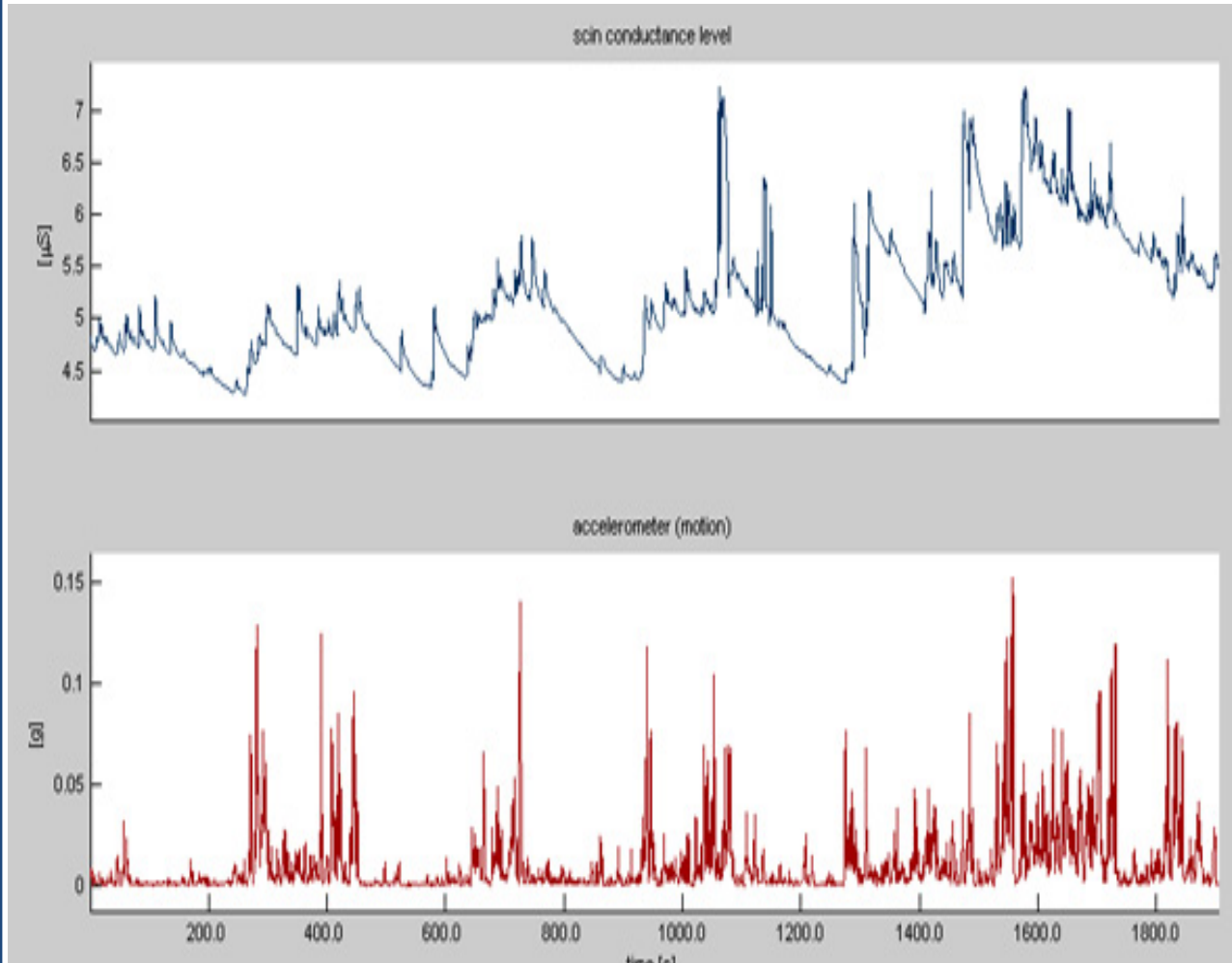
~ 30 seconds to a minute per event
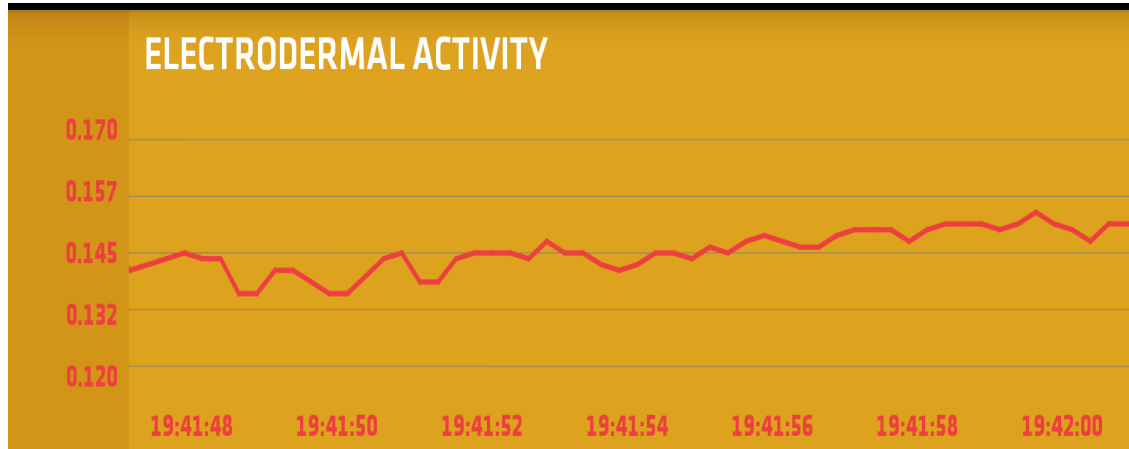
TYPING

MOVING HAND

STAYING STILL

TALKING

Data Collection Considerations

Movement/Talking

Movement can introduce a lot of noise to your EDA data; since sweat secretion increases conductivity, so will movement.

Risks generating false data if not processed correctly

Talking can minimize EDA; since it involves cognitive processes, other forms of ANS activation are introduced and thus will be hard to interpret data

Variance

Some tasks (e.g. Self-Reports) may not yield variable data unless designed to do so

Data Collection Considerations

Timestamping

Definition of an event is needed (micro- versus macro-event)

Timestamping events is pivotal to data analysis

If using other tools (e.g., video cameras, facial expressions), the times between the EDA sensor and tool must be synched

Location of Sensor

Fingers, Palms, Feet

Numbers of sensors to use (2 sensors, 1 per hand, etc)

Collection Frequencies of Sensor
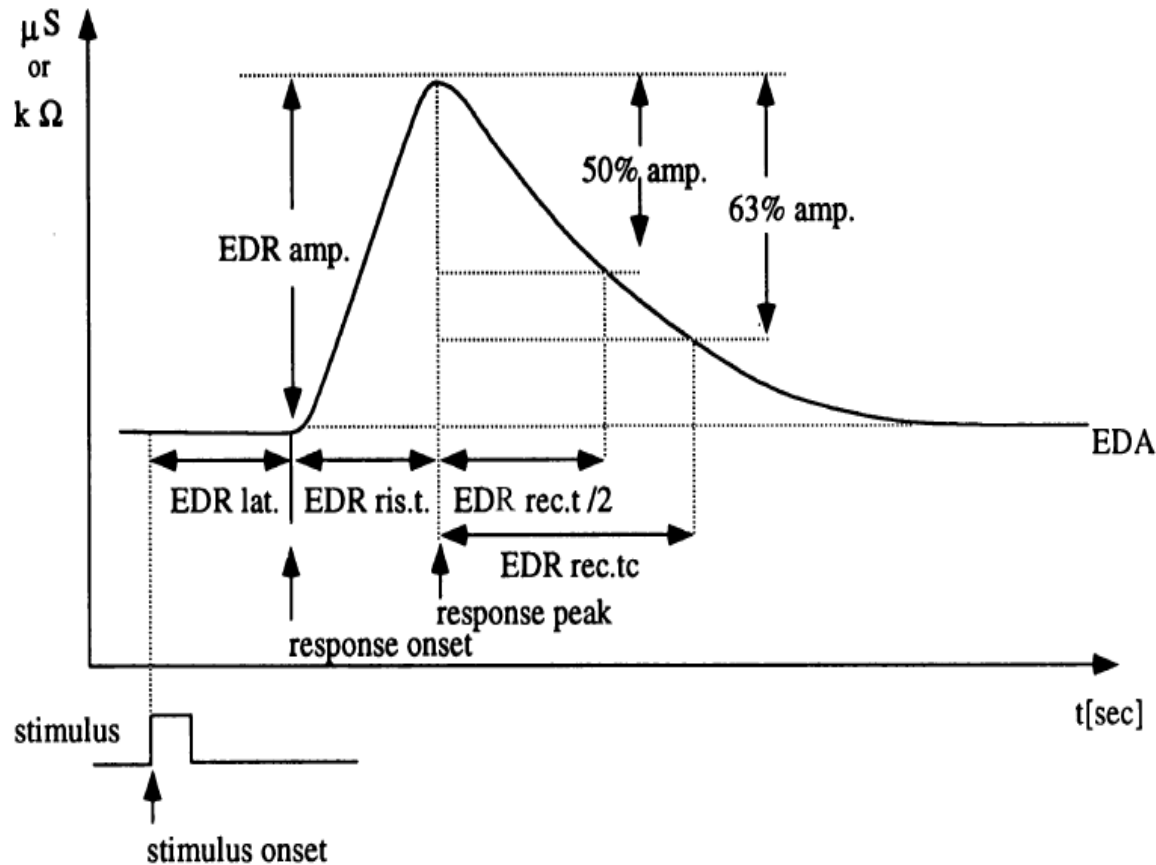
8Hz, 16Hz, or higher

Diet

Caffeine, Sugar

Temperature

Hot, Cold

Data Analysis Considerations

Filters

Depending on the program, the type of filter used to remove noise from the EDA data may vary

Empatica (Does not provide; suggests use of open sources software such as LedaLab or EDAXplore)

iMotions (Provides integrated software that depends on Median Filtering; not useful for talking or movement type of experiments)
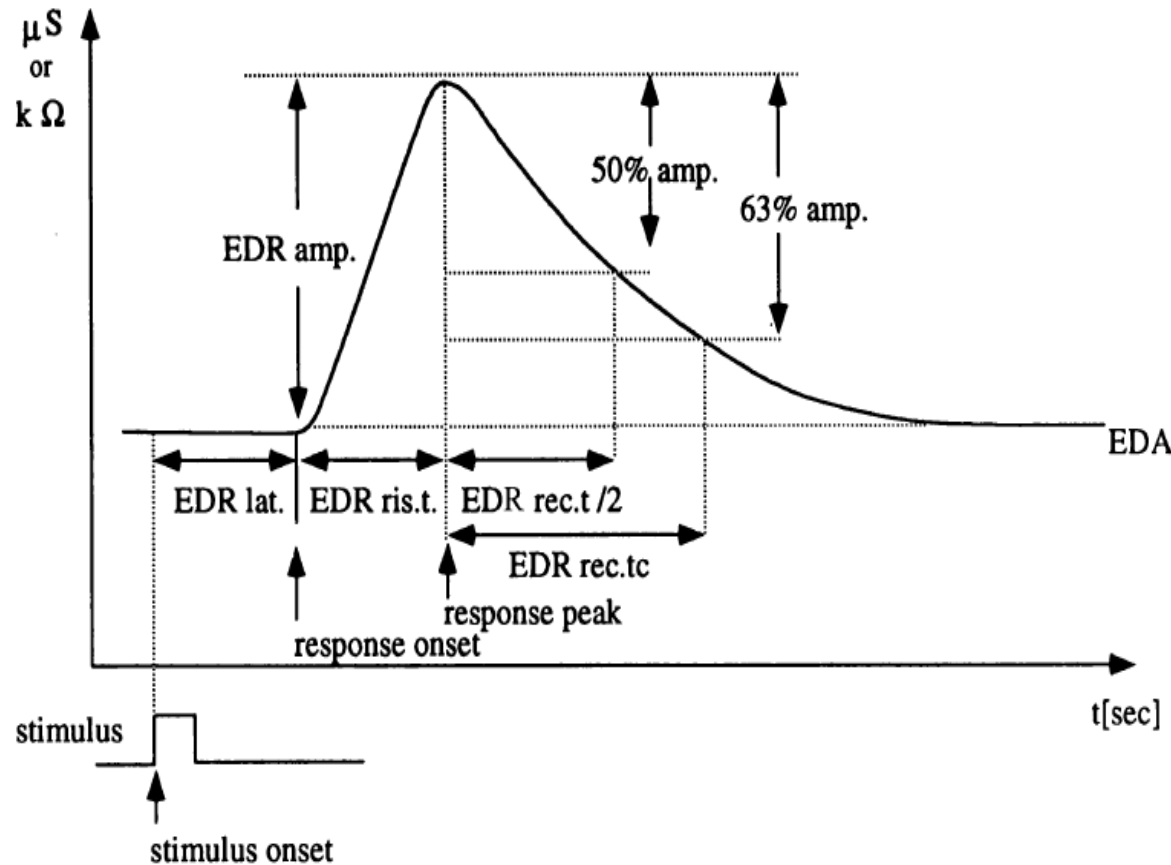
Reporting

Amplitudes

Frequencies

Latencies

Data Analysis Considerations

Statistical Analysis

Time Series

Counterbalancing

Crossover

Autocorrelation

Other

Individual or Group Analysis

Analyze processed data based on an individuals' baseline

Analyze processed data based on a groups' mean baseline

Both

EDA Limitations

While EDA is a powerful tool to measure arousal, it cannot measure the valence or activation of an emotion

- Other tools are needed in conjunction (e.g., self-reports)

Timestamping, movement, talking can all contribute to the way that the EDA raw data is processed

Processing EDA data requires expertise in signal processing and filtering

Analyzing EDA data requires expertise from statisticians or experts on complex data systems and analysis

- Same applies if correlations are to be sought between multiple modes of emotional research (e.g., facial expressions and electrodermal activity)

Research presented here was supported by

This material is based upon work supported in part by Utah State University (USU) Research Catalyst SEED Funding and National Science Foundation (NSF) No. EEC-1653140 and EEC-1661117. Any opinions, findings and conclusions or recommendations expressed in this material do not necessarily reflect those of NSF or USU.
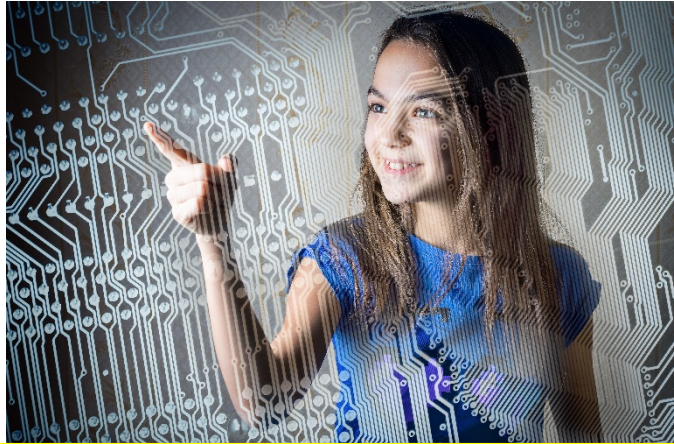
2018 Gender and STEM Network Conference

Reimagining Who Does STEM and Why Through Research, Education, and Action

July 31-August 2, 2018

University of Oregon Eugene, OR USA

Keynote addresses by Dr. Jacquelynne Eccles, Dr. Kimberly Scott, Dr. Kathryn Scantlebury, and Dr. Alice Pawley

If you have any further questions about the conference, please don't hesitate to contact us at conference@genderandSTEM.com

For more detailed information about the conference program and registration please visit our website:
http://www.STEM2018@uoregon.edu

Important Dates
The deadline for submission of proposals is November 27, 2017
Information about acceptance will be sent out by January 12, 2018. The deadline for early registration is May, 1, 2018

An equal-opportunity, affirmative-action institution committed to cultural diversity and compliance with the Americans with Disabilities Act. This pub- lication will be made available in accessible formats upon request.

NETWORK GENDER & STEM
educational and occupational pathways and participation

VhTo NATIONAL EXPERT ORGANISATION ON GIRLS/WOMEN AND SCIENCE/TECHNOLOGY

UNIVERSITY OF OREGON College of Education

Questions?

Idalis Villanueva, Utah State University, idalis.Villanueva@usu.edu
Jenefer Husman, University of Oregon, jhusman@uoregon.edu
Katherine Cheng, University of Nebraska-Lincoln, kcheng13@asu.edu