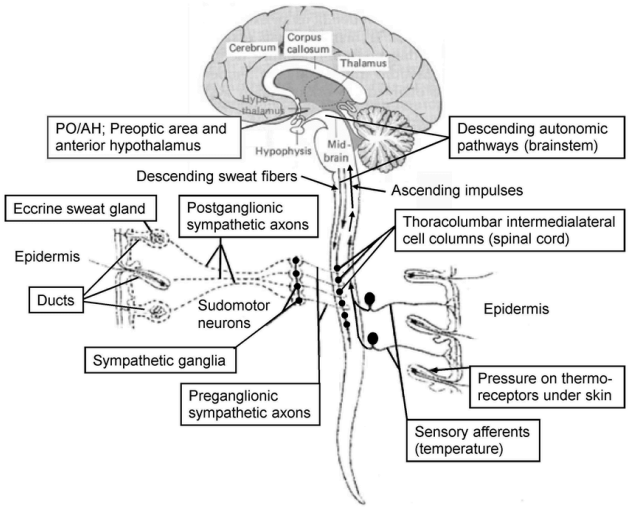
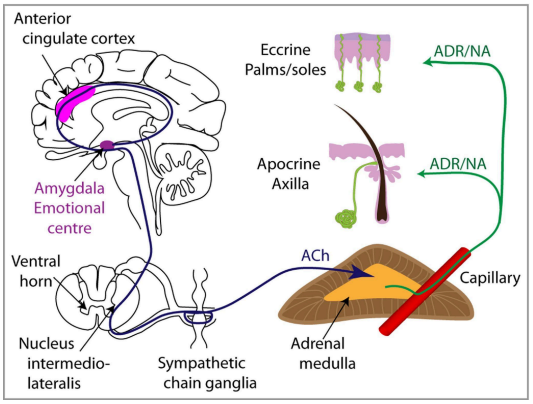
EDA: monitoring psychological stress by assessment of galvanic skin response

Electrodermal activity (EDA), or galvanic skin response or GSR, indicates the measurement of continuous changes in the **electrical conductance of the skin**.
EDA is modulated by the activity of the sympathetic nervous system (SNS), a component of the autonomic nervous system (ANS), which is involved in the control of involuntary bodily functions as well as cognitive and emotional states.

Electrodermal activity is related to a person's psychological-emotional arousal. Indeed, eccrine sweat glands are innervated by the sympathetic sudomotor nerves.
When a person is psychologically aroused or excited, the sympathetic nervous system is activated, increasing the activity of the eccrine sweat glands and consequently skin conductance.
Thus, EDA is a direct expression of emotional autonomic regulation and, although it cannot be used to distinguish different emotional states, it is a useful parameter for assessing a patient's psychological state.

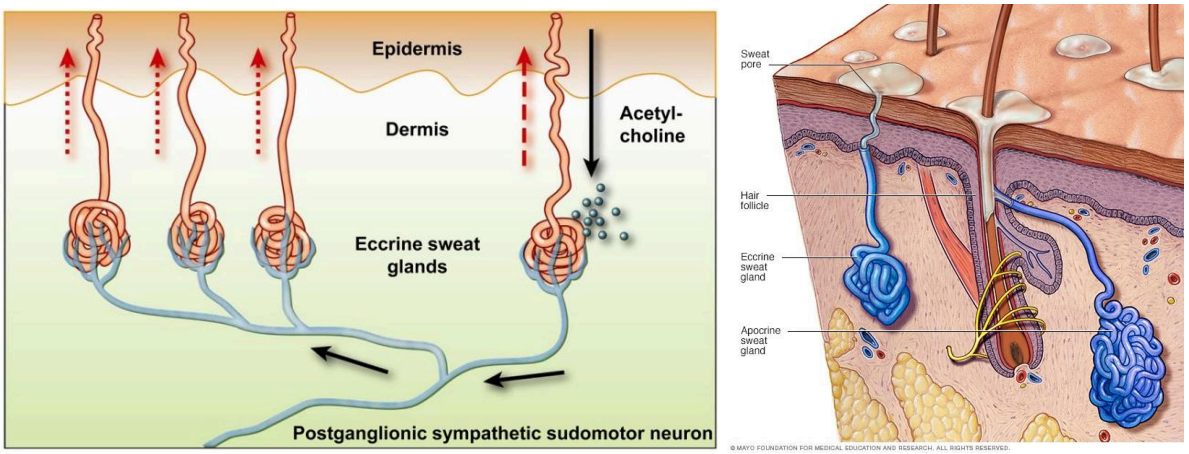
ANATOMY





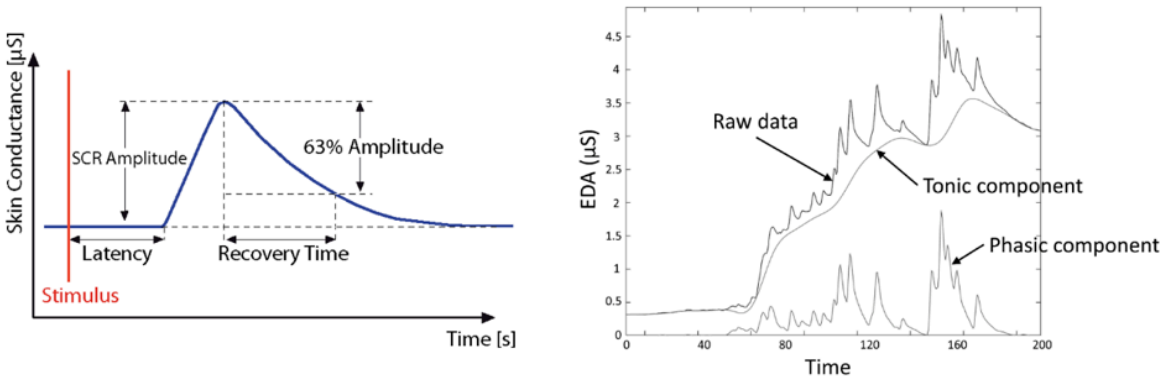
The skin is associated with the peripheral sensory nervous system (PNS), autonomic nervous system (ANS), and central nervous system (CNS). Various stressors activate the hypothalamus/pituitary gland within the CNS, resulting in the release of several neuromediators.

The efferent sympathetic fibers start from the control centers of the cerebral autonomic nervous system and then continue into the ventral horns of the spinal cord. They subsequently form sympathetic ganglia and terminate by innervating the eccrine sweat glands.



The onset of stress is associated with a change in body temperature: the central temperature tends to rise, while in the peripheral areas there is a lowering of heat caused by vasoconstriction.
Electrodermal activity reacts to the vaso-constrictive action and is followed by a galvanic skin response and sweating.

THE SIGNAL



EDA is typically divided into two components, one that considers the **skin conductance level** (SCL) and the other the **skin conductance response** (SCR).

The first component, **basal** or tonic, varies gradually over several minutes and is an index of the baseline level of eccrine gland activity.

The second is the **phasic** component, which consists of pulsatile sweat release events. These events are fast, distributed over a time scale of a few seconds, and represent the **variability of eccrine activity caused by specific emotional stimuli**.

In other words: the SCL value indicates the subject's level of psychological arousal, while the SCR value represents a **measure of the subject's momentary arousal**.

Phasic phenomena are thus electrodermal **responses** (electrodermal response or EDR) to eliciting stimuli, or those of unknown origin and labeled as non-specific responses (NS). Instead, tonic phenomena are reflected in electrodermal **levels** (EDL).

The spectral band most sensitive to central sympathetic control of resting EDA is confined between **0.045 and 0.25 Hz**.

MEASUREMENT

There are two methods of measuring EDA:

- **Endosomatic measurement:** it uses an external electric current that passes through the skin by the application of electrodes on the surface. It is the most discrete detection system, as it can differentially reflect the various processes that occur during phasic EDA.
  It does not require special amplification or coupling systems, and the measurement can be performed by electroencephalogram (EEG) or electromyogram (EMG) amplifiers that have a sufficiently large input impedance, in the case of DC amplifiers, or a sufficiently long control time so as not to distort the waveforms, in the case of R-C coupled amplifiers. Direct interpretation of the resulting SPRs, however, can be complicated.

- **Exosomatic measurement**: involves monitoring voltage differences between the two electrodes and measures internally generated skin electrical potentials, without application of an external event.
  - **Direct current measurement**: based on a constant voltage system, it is the most popular method in psychophysiology. Some researchers, however, are concerned that even with non-polarizing Ag/AgCl electrodes there is a risk of electrode polarization, and thus a dependence of skin conductance on counterelectrode generation.
  - **Alternating current measurement:** aims to avoid problems of polarization and induction of electromagnetic fields. Its application to research would allow determination of possible capacitive changes in electrodermal levels and responses. It may require electrodes, electrode gels and special recording devices, which may be different from those used for other psychophysiological measurements.

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