The Autonomic Nervous System and Resiliency

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Disclosures: None
ACh

(Many)
Enteric Parasympathetic Cholinergic Sympathetic Noradrenergic Sympathetic Adrenergic

ANS

Langley

Cannon

Dale

ENS PNS SNS SAS SCS

(Many) ACh NE EPI ACh

Enteric Parasympathetic Cholinergic Sympathetic Noradrenergic Sympathetic Adrenergic Sympathetic Cholinergic
Adapted from Damasio, A. Descartes' Error. Emotion, Reason, and the Human Brain
Error Control
(Negative Feedback Reflexive)

Anticipatory
(Feed-forward Instinctive)

Anticipatory
(Feed-forward Conditioned)

Buffering

Sensor for Conditioned Stimulus
Conditioned Stimulus
Conditioned Awareness
Unconditioned Awareness
Memory
Regulator
Effectors
Regulated Variable
Buffer

Stimulus or Disturbance

Goldstein & Kopin Auton Neurosci 2017;208:15–28
<table>
<thead>
<tr>
<th>Condition</th>
<th>SNS</th>
<th>SAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-Deoxyglucose (glucoprivic stress)</td>
<td>+</td>
<td>++++++</td>
</tr>
<tr>
<td>Distress</td>
<td>+</td>
<td>++++</td>
</tr>
<tr>
<td>Autonomically mediated syncope (fainting)</td>
<td>+</td>
<td>++++++</td>
</tr>
<tr>
<td>Orthostasis</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>Mild exercise</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>Cool temperature at skin of back</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>Mild core hypothermia</td>
<td>+++</td>
<td>+</td>
</tr>
</tbody>
</table>
Stressor
Afferent Information
Monitored Variable
Regulator Set point and other instructions
Homeostat
Afferent Information
Monitored Variable
Stressor
Effector Use
WEAR AND TEAR
Intrinsic Degeneration
Declining efficiency
STRESS
ALLOSTATIC LOAD
Goldstein DS. Compr Physiol 2013;3:1569-1610
STRESS

ALLOSTATIC LOAD

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Conclusions

- It’s time to move beyond Langley’s ANS (EAS=ANS+neuroendocrinology+immune/inflammatory systems+central autonomic network)

- It’s time to move beyond negative feedback regulation: Feed-forward (allostasis) regulation, buffering

- It’s time to move beyond Selye: Primitive specificity of stress responses

- It’s time to move beyond systems biology vs. integrative physiology: Darwinian medicine.