“Little Brain” Within the Heart

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- The heart's "Big Boss" is the heart: BP control, HR control
- Knife-edge scanning microscopy, creating detailed pictures of heart anatomy
- They play crucial role in heart health, helping to fine-tune heart rhythms and perhaps protecting people against certain kinds of heart disease.
- Normal resting rhythm of the heart is the basis of heart rate variability (HRV).
- Most of these neuron clusters dot the top of the heart, where blood vessels come in and out. Some of these clusters spread down the back of the heart, and are particularly abundant on the left side.

Intracardiac Nervous System

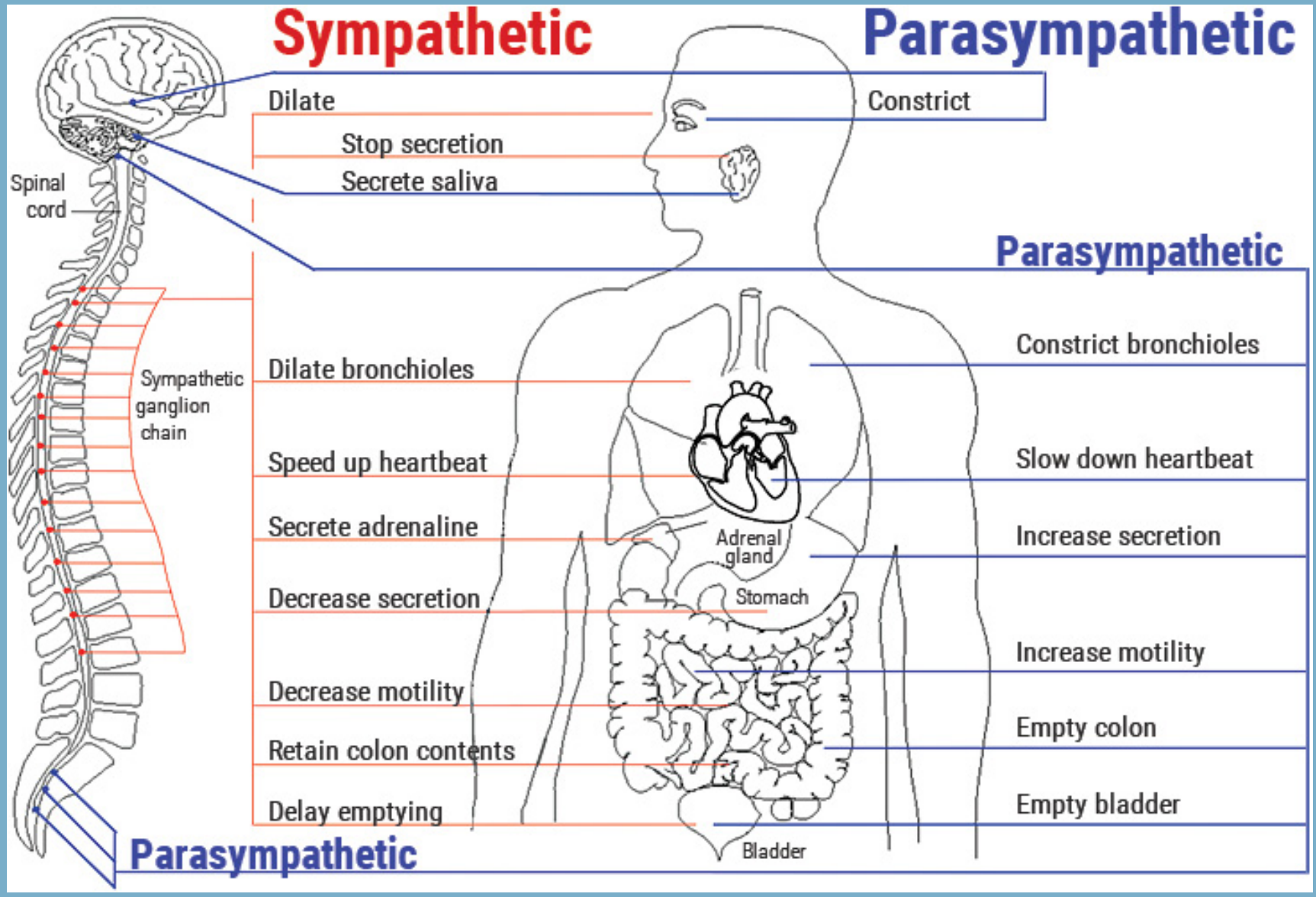
- Traditionally, the study of communication pathways between the head and heart has been approached from a rather one-sided perspective, with scientists focusing primarily on the heart's responses to the brain's commands.
- Dynamic, ongoing, two-way dialogue, with each organ continuously influencing the other's function
- Research has shown that the heart communicates to the brain in four major ways:

  Neurologically (through the transmission of nerve impulses).

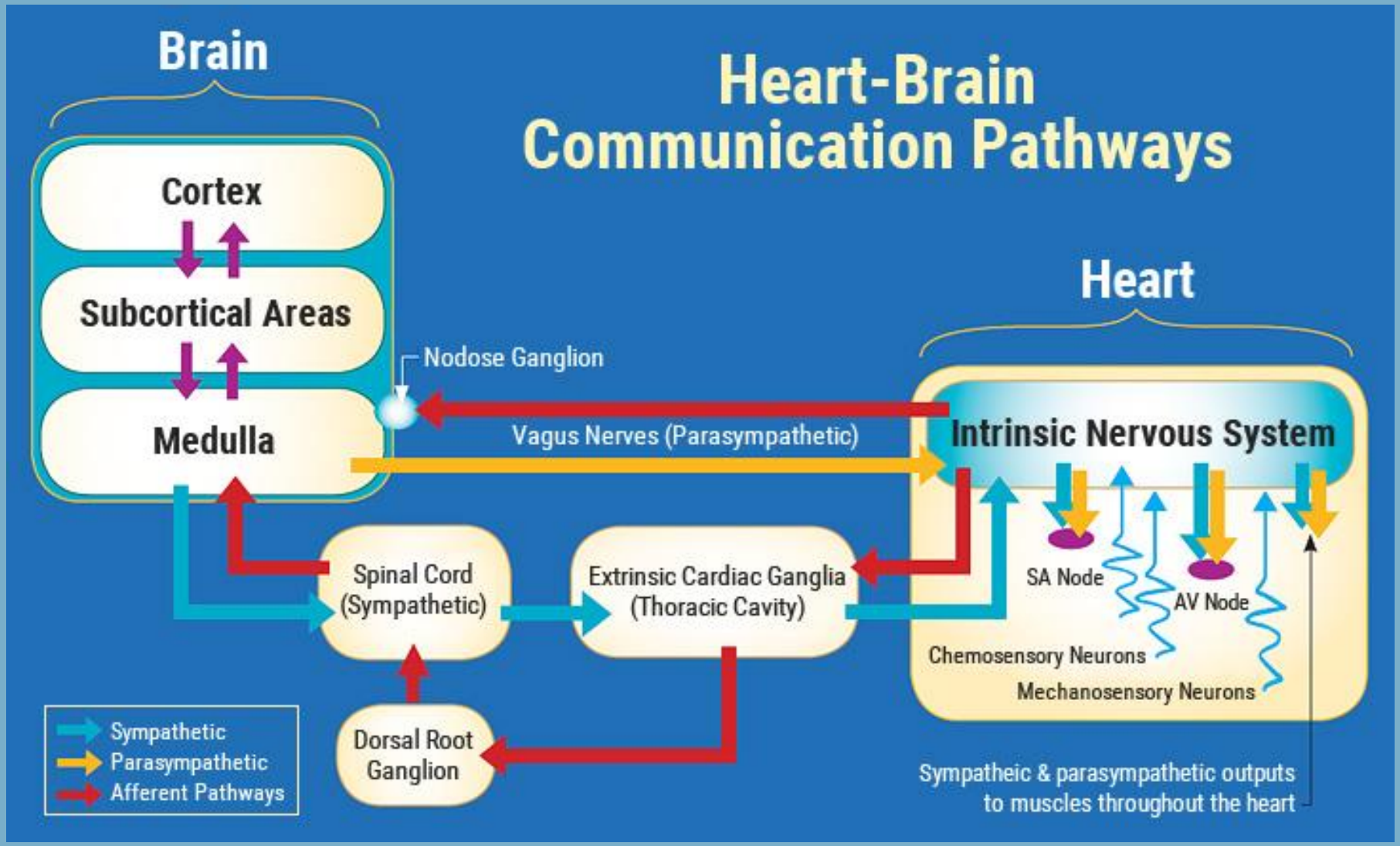
  Biochemically (via hormones and neurotransmitters),

  Biophysically (through pressure waves) and

  Energetically (through electromagnetic field interactions).


Sympathetic
Parasympathetic
Dilate
Constrict
Stop secretion
Secrete saliva
Spinal cord
Parasympathetic
Sympathetic ganglion chain
Dilate bronchioles
Constrict bronchioles
Speed up heartbeat
Slow down heartbeat
Secrete adrenaline
Adrenal gland
Increase secretion
Decrease secretion
Stomach
Increase motility
Decrease motility
Empty colon
Retain colon contents
Delay emptying
Empty bladder
Bladder
Parasympathetic

- Cardiovascular activity influences perception and cognitive performance
- It is the pattern and stability of the heart's rhythm of the afferent (ascending) inputs, rather than the number of neural bursts within the cardiac cycle, that are important in modulating thalamic activity, which in turn has global effects on brain function.
- The heart-brain's neural circuitry enables it to act independently of the cranial brain to learn, remember, make decisions and even feel and sense
- Descending activity from the brain in the head via the sympathetic and parasympathetic branches of the ANS is integrated into the heart's intrinsic nervous system along with signals arising from sensory neurons in the heart that detect pressure, heart rate, heart rhythm and hormones.


Brain
Heart-Brain Communication Pathways
Cortex
Subcortical Areas
Medulla
Nodose Ganglion
Vagus Nerves (Parasympathetic)
Heart
Intrinsic Nervous System
Spinal Cord (Sympathetic)
Extrinsic Cardiac Ganglia (Thoracic Cavity)
SA Node
AV Node
Chemosensory Neurons
Mechanosensory Neurons
Dorsal Root Ganglion
Sympathetic
Parasympathetic
Afferent Pathways
Sympatheic & parasympathetic outputs to muscles throughout the heart

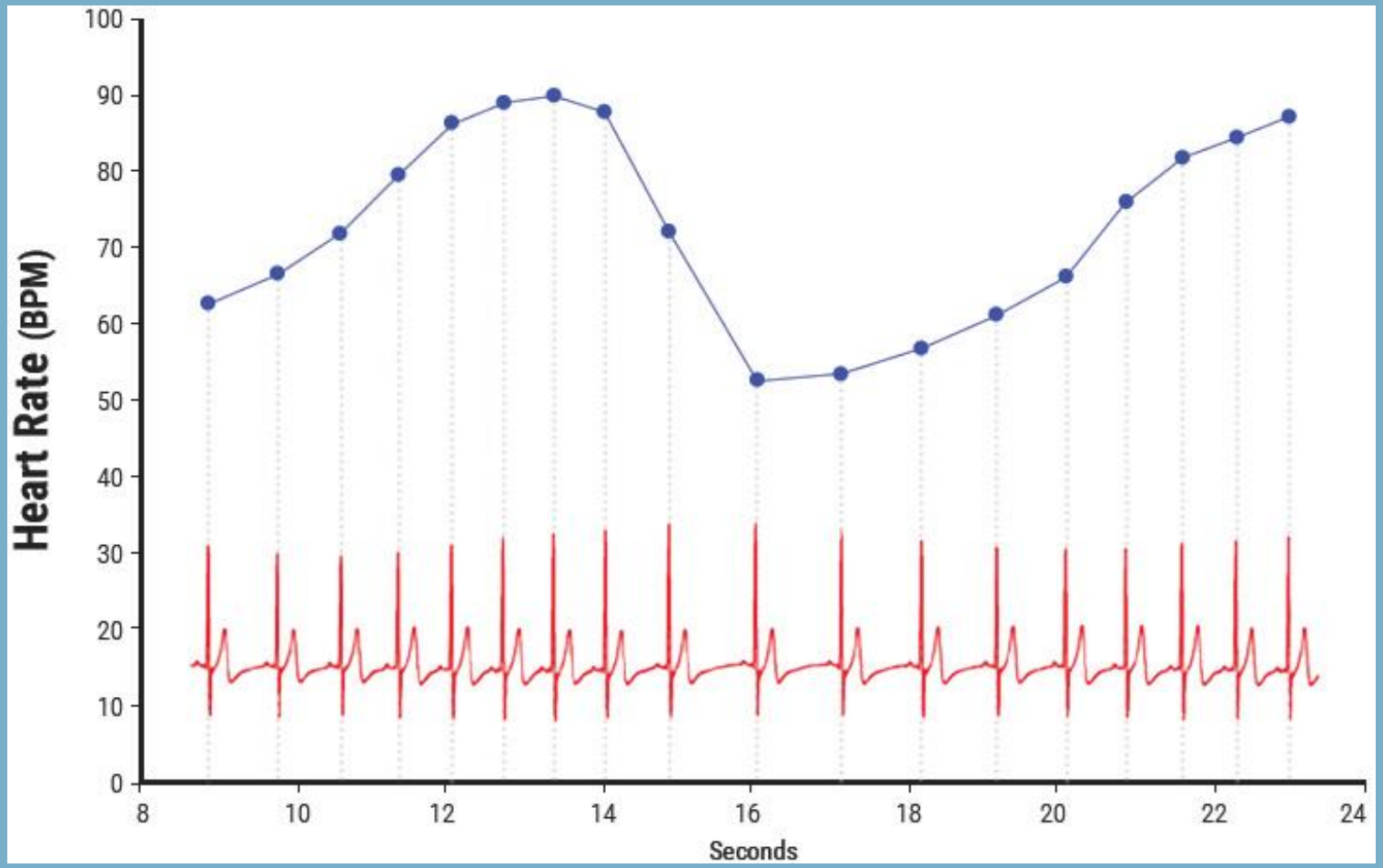
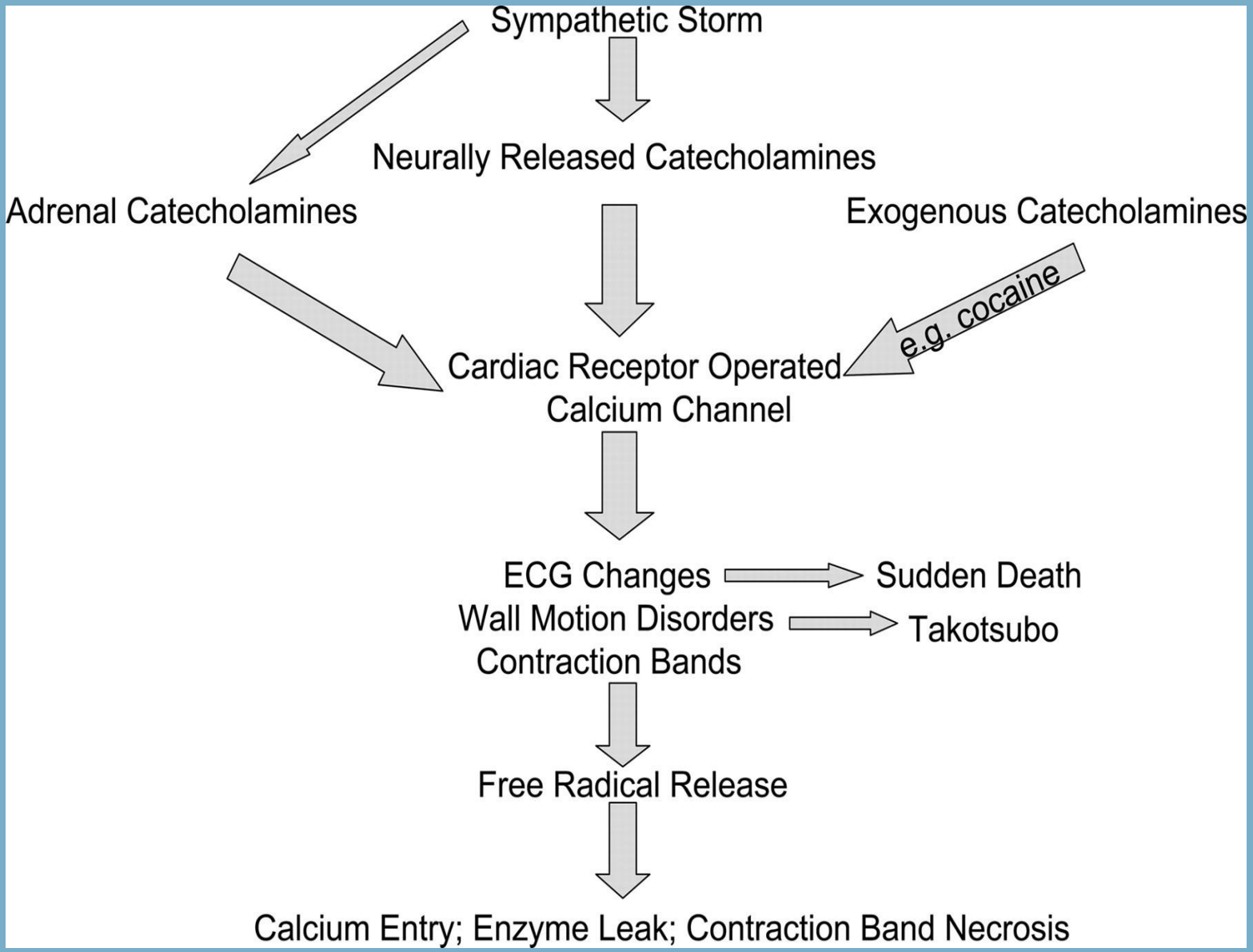


Figure 3.1 Heart rate variability is a measure of the normally occurring beat-to-beat changes in heart rate. The electrocardiogram (ECG) is shown on the bottom and the instantaneous heart rate is shown by the blue line. The time between each of the heartbeats (blue line) between 0 and approximately 13 seconds becomes progressively shorter and heart rate accelerates and then starts to decelerate around 13 seconds. This pattern of heart-rate accelerations and decelerations is the basis of the heart's rhythms.


Sympathetic Storm
Neurally Released Catecholamines
Adrenal Catecholamines
Exogenous Catecholamines
e.g. cocaine
Cardiac Receptor Operated
Calcium Channel
ECG Changes
Sudden Death
Wall Motion Disorders
Takotsubo
Contraction Bands
Free Radical Release
Calcium Entry; Enzyme Leak; Contraction Band Necrosis

- Arrhythmias
- Refractory hypertension
- Takastubo’s Cardiomyopathy
- SCD

- Strokes

Table 1. Manifestations of sympathetic and parasympathetic hyperactivity. Collapse

sympathetic hyperactivity	parasympathetic hyperactivity
hypertension	hypotension
tachycardia	bradycardia
hyper- or hypothermia	lacrimation and sialorrhoea
hyperhidrosis	yawning
mydriasis	miosis

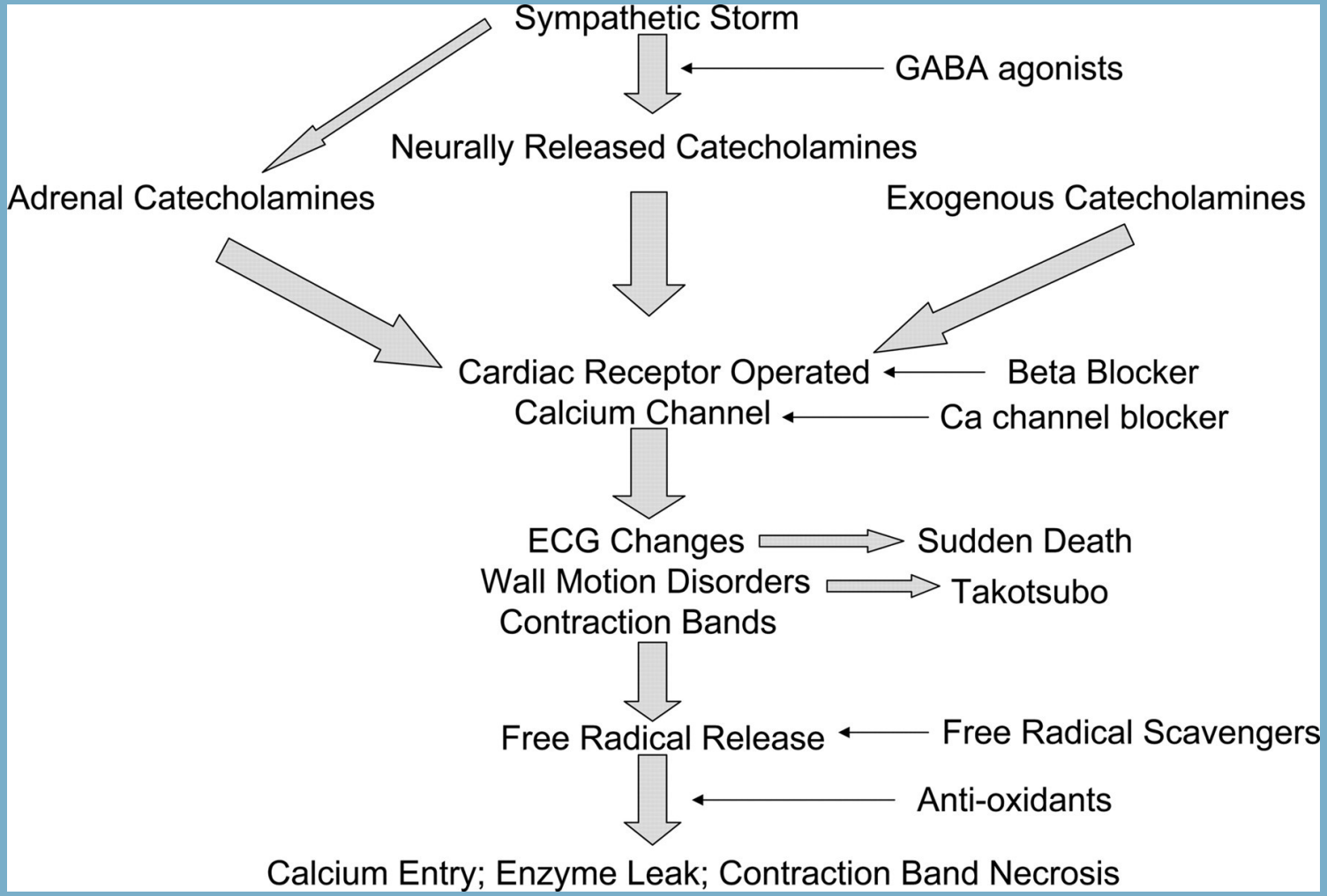
Table 2. Manifestations and complications of paroxysmal autonomic hyperactivity.

paroxysmal autonomic hyperactivity	
manifestations	**complications**
hypertension	intracerebral haemorrhage, vasogenic cerebral oedema
labile blood pressure	compromised cerebral perfusion
neurogenic cardiac injury	apical ballooning syndrome (takotsubo syndrome)
tachyarrhythmias	ventricular tachycardia and fibrillation
bradyarrhythmias	asystole
neurogenic lung injury	pulmonary oedema, hypoxia
hyperthermia	worse neurological recovery
hyperhidrosis	dehydration
muscle rigidity	rhabdomyolysis, acute tubular necrosis

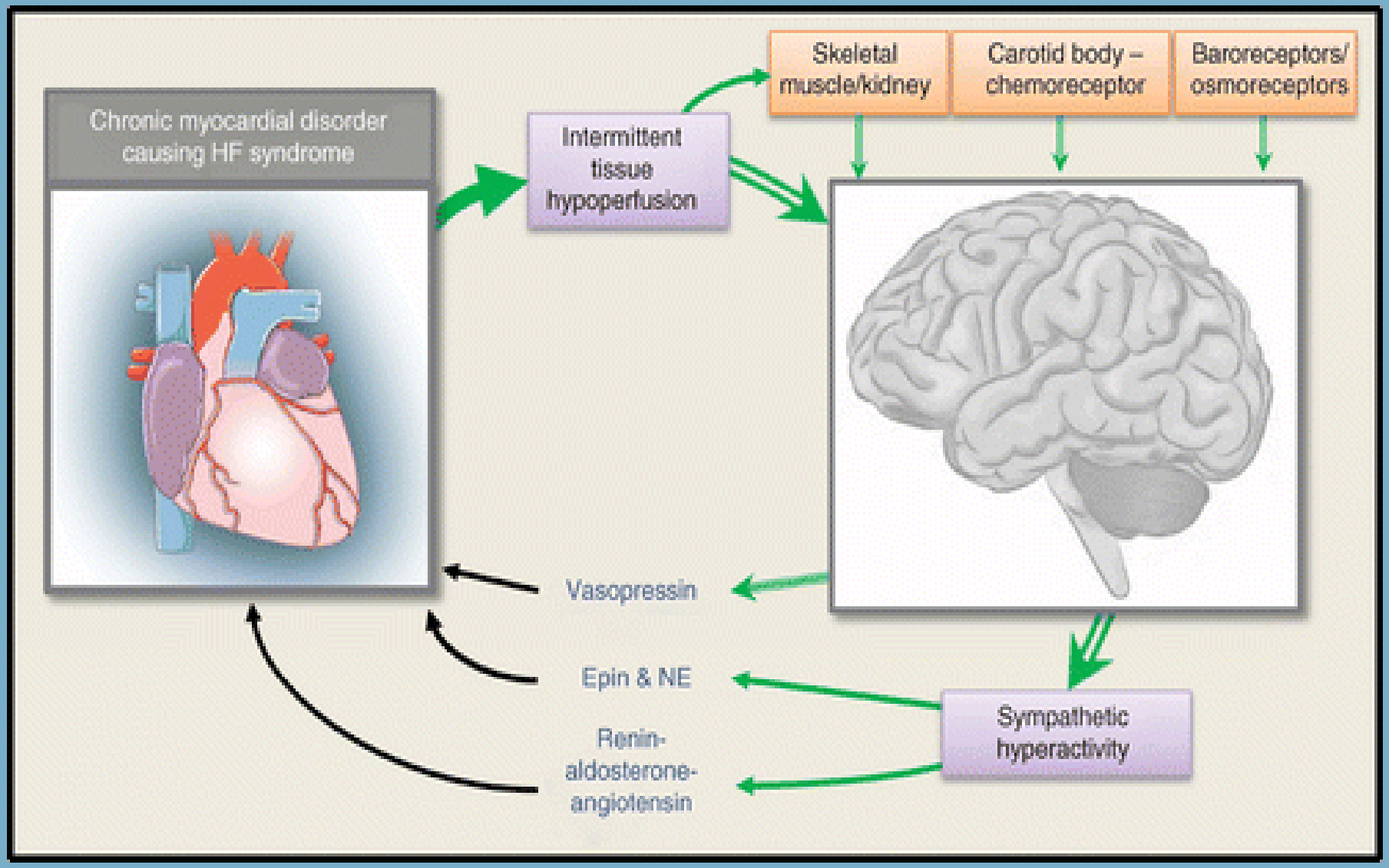
Table 3. Disorders associated with chronic autonomic hyperactivity.

chronic autonomic hyperactivity-associated disorders
obesity
diabetes, insulin resistance
hypertension
insomnia and anxiety
hyperthermia
high energy expenditure
muscle wasting
increased susceptibility to infection
impairment of memory

Potential Treatments



Heart Failure and the Brain



Psychology and the Heart

- Thoughts and even subtle emotions influence the activity in the autonomic nervous system.
- The ANS interacts with our digestive, cardiovascular, immune, hormonal and many other bodily systems.
- Negative emotions/feelings create disorder in the brain's regulatory systems and ANS.
- Feelings such as appreciation create increased order in the brain's regulatory systems and ANS, resulting in improved hormonal- and immune-system function and enhanced cognitive function

Psychology-Heart Ecosystem

- Previous studies have linked negative emotions, including depression, anxiety, and anger, to a heightened risk of heart disease.
- If a person develops a major depression following a heart attack, a rather common occurrence, they will be consistently at a three-fold increased risk of death.
- Those who lost a spouse are more likely to have sleep disturbances that make them more vulnerable to develop inflammation, which in turn raises their risk to develop cardiovascular illness and death.
- Sustained stress, anger, and anxiety can disrupt cardiac function by changing the heart's electrical system, hastening atherosclerosis, and increasing systemic inflammation.

Neurological Conditions and Heart

- Stroke
- Anoxic brain injury
- A wide variety of changes in the ECG is seen in the context of neurological disease. Two major categories of change are regularly noted: arrhythmias and repolarization changes

- Parkinsonism
- Autonomic dysfunction due to neuropathy, alcohol
  - BP/ HR fluctuations

Prevention

- It seems that if we exercise regularly, our autonomic nervous system adapts to control the heart more efficiently. When people develop heart disease, the opposite happens: the autonomic nervous system becomes less active and doesn't talk to the heart as much.
- Smoking
- Alcohol
- Stress management
- Medications: Beta blockers, High BP meds,
- Drugs that prevent stroke :
  - Statins
  - Blood thinners

Thank you