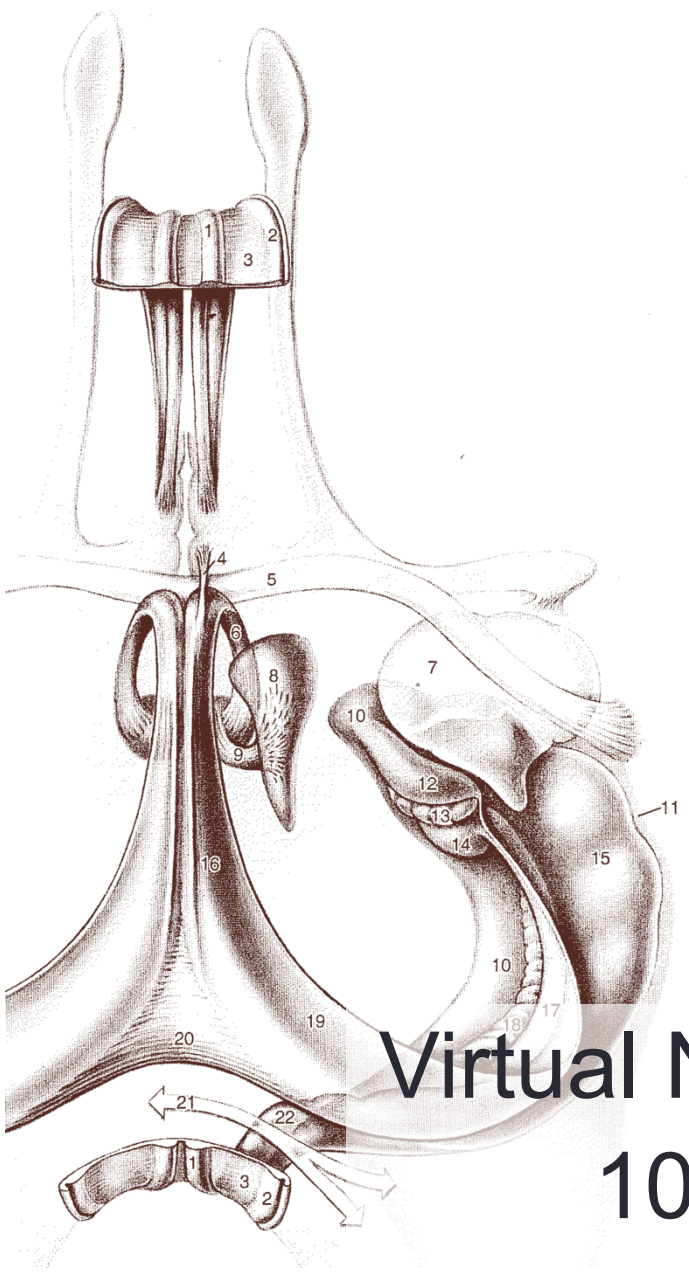
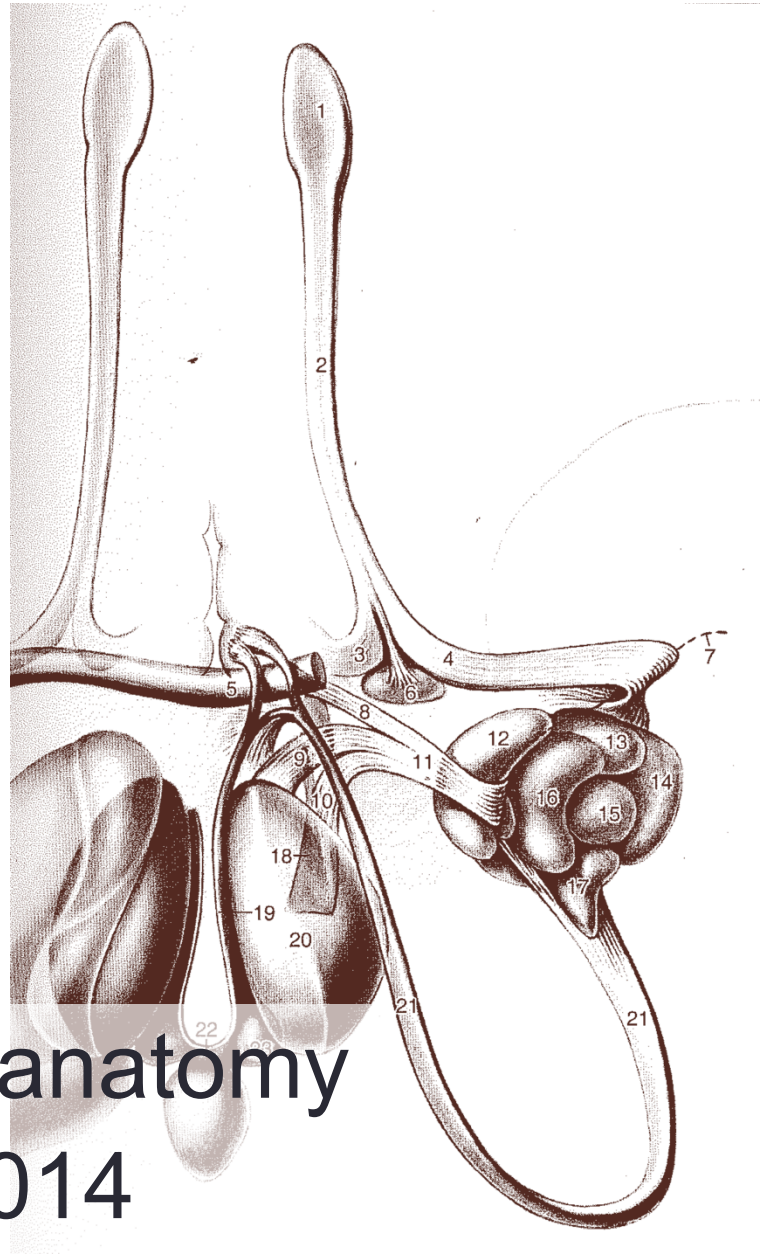
Fornix & Stria Terminalis

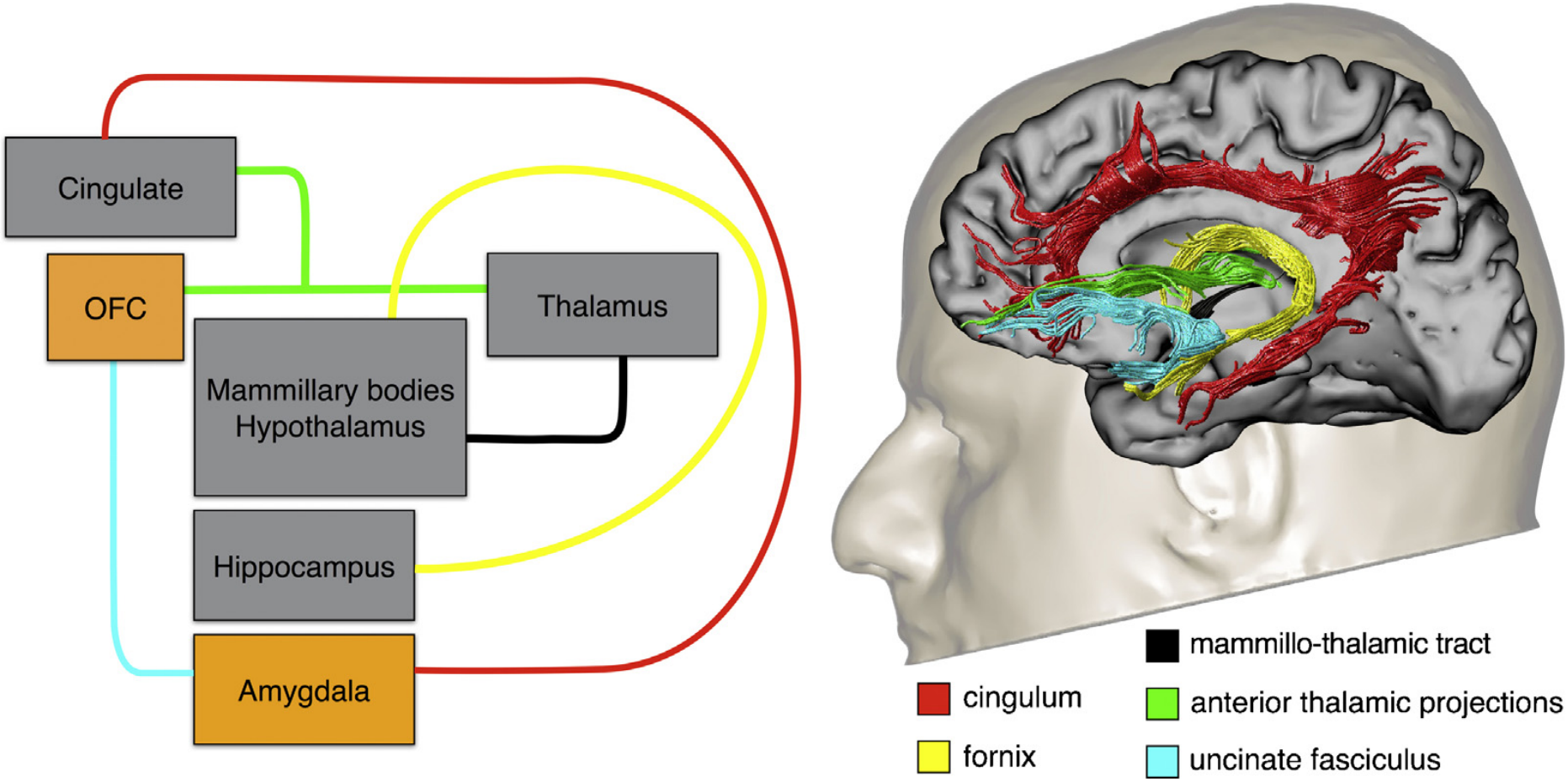




Virtual Neuroanatomy

10/21/2014

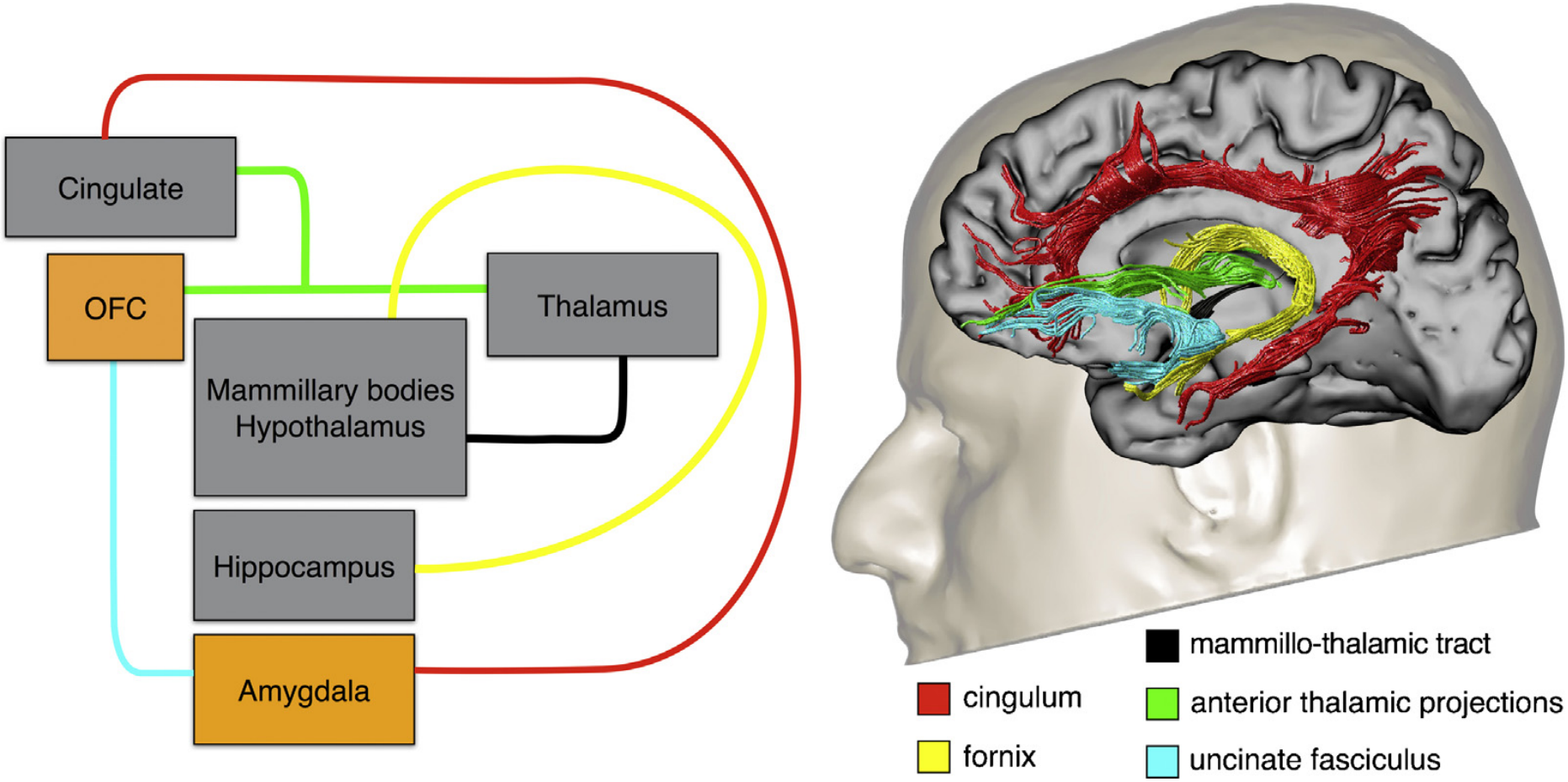
Background: Limbic System



Interconnected cortical and subcortical regions that link visceral states and emotion to cognition and behavior.

Catani et al. 2013

Background: Limbic System

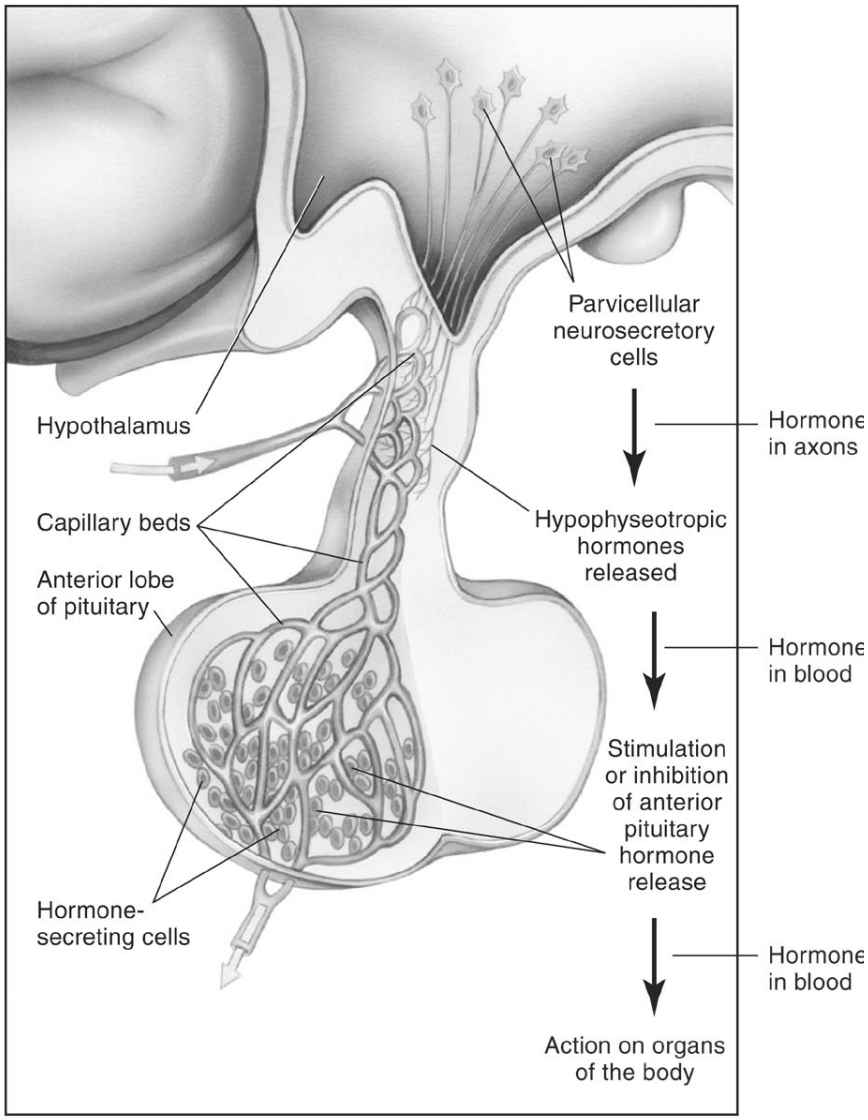


Interconnected cortical and subcortical regions that link visceral states and emotion to cognition and behavior.

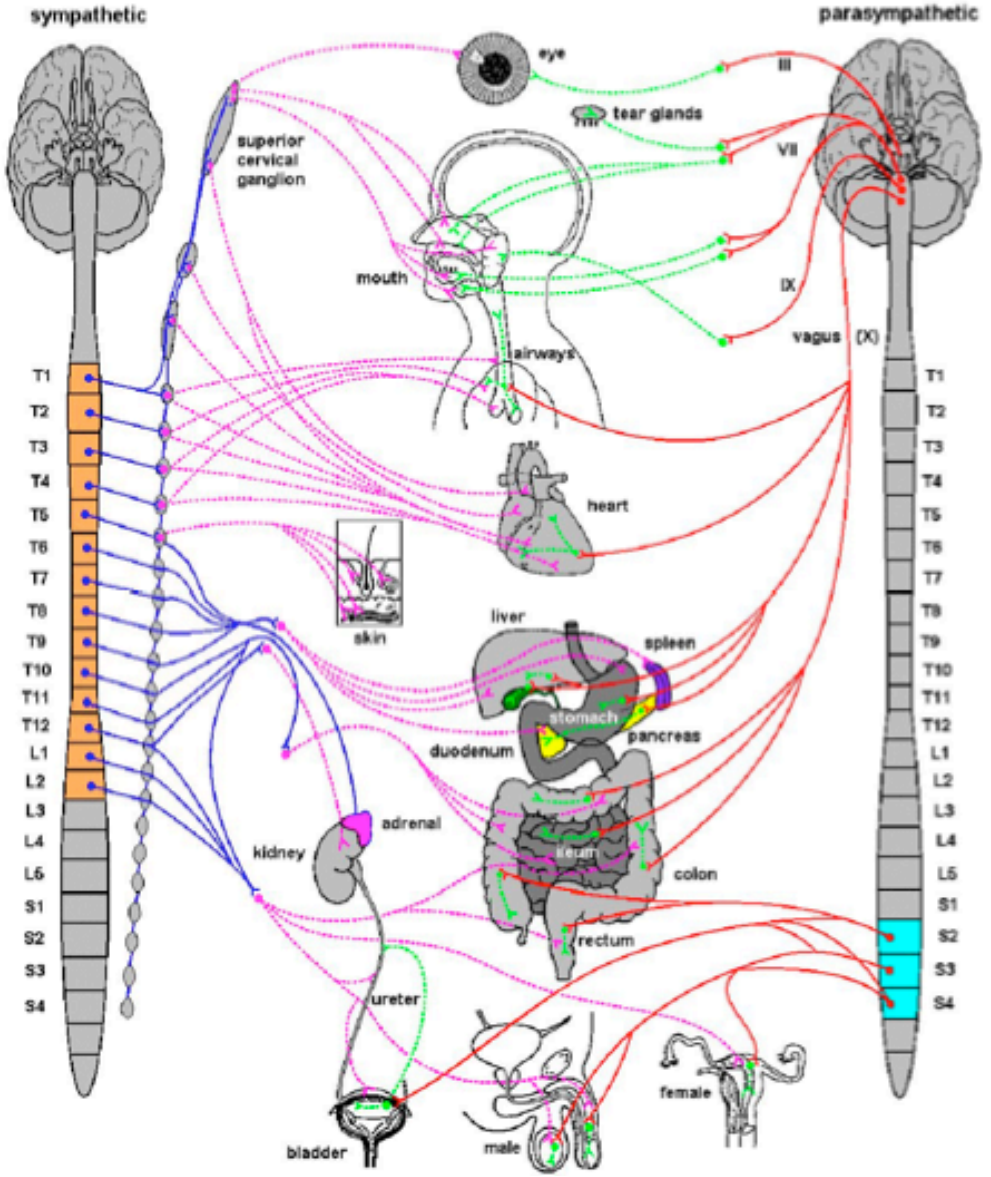
Catani et al. 2013

Background: Visceral Regulation

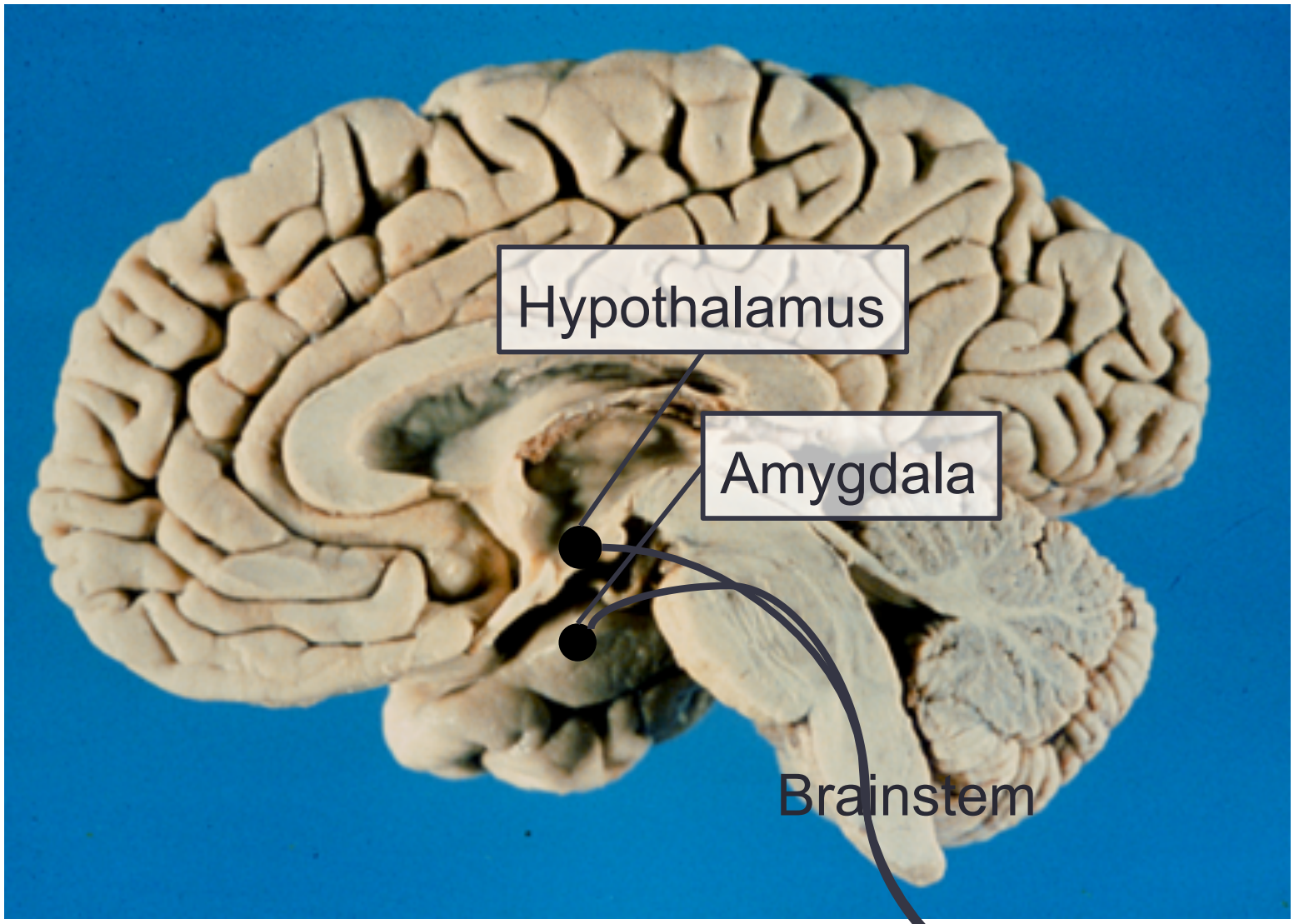
Neuroendocrine



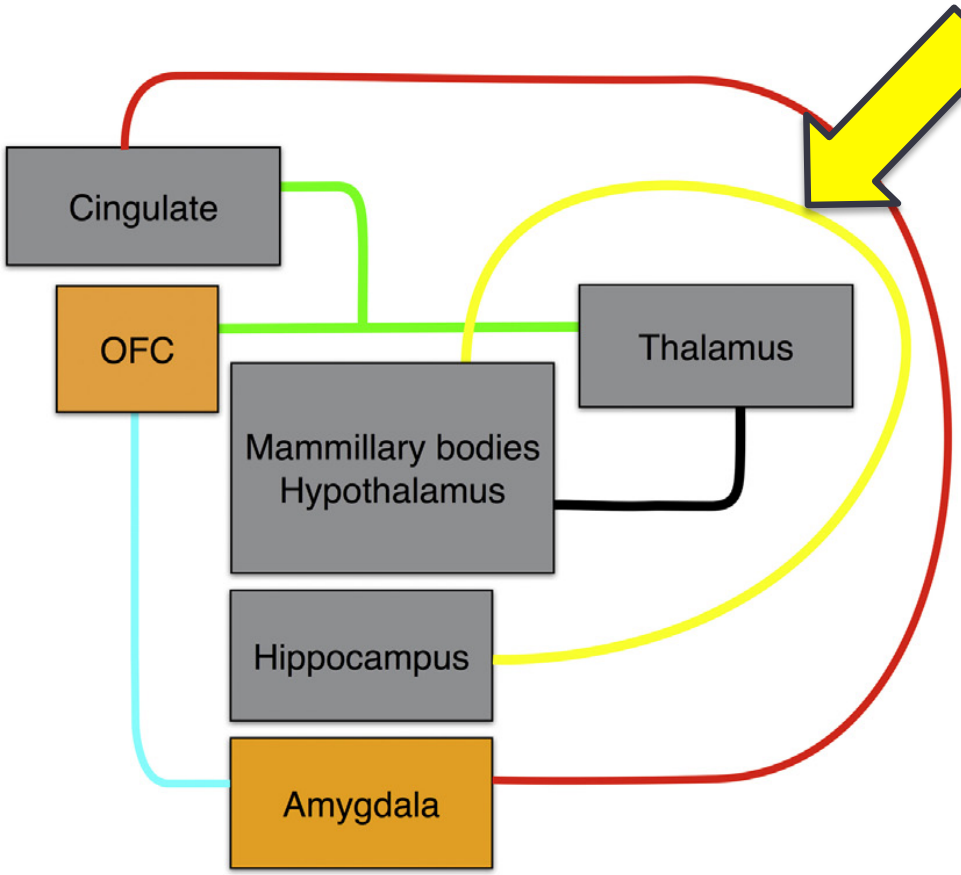
Autonomic

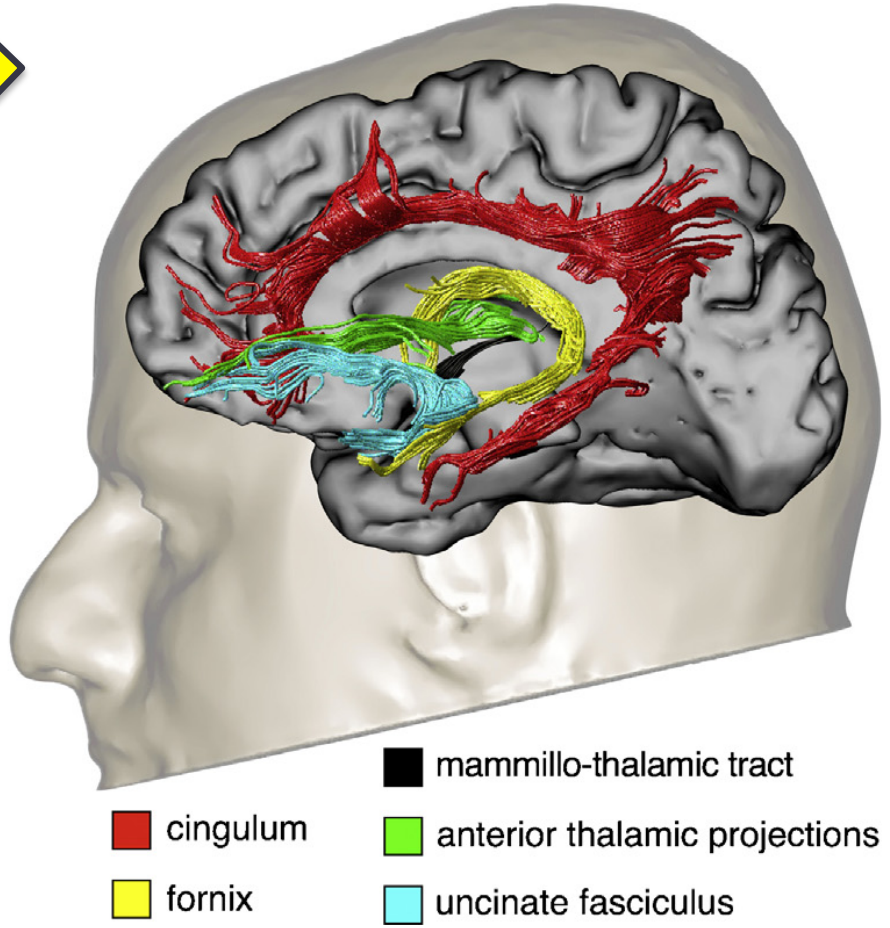


Background: Key Limbic Regions are Visceral



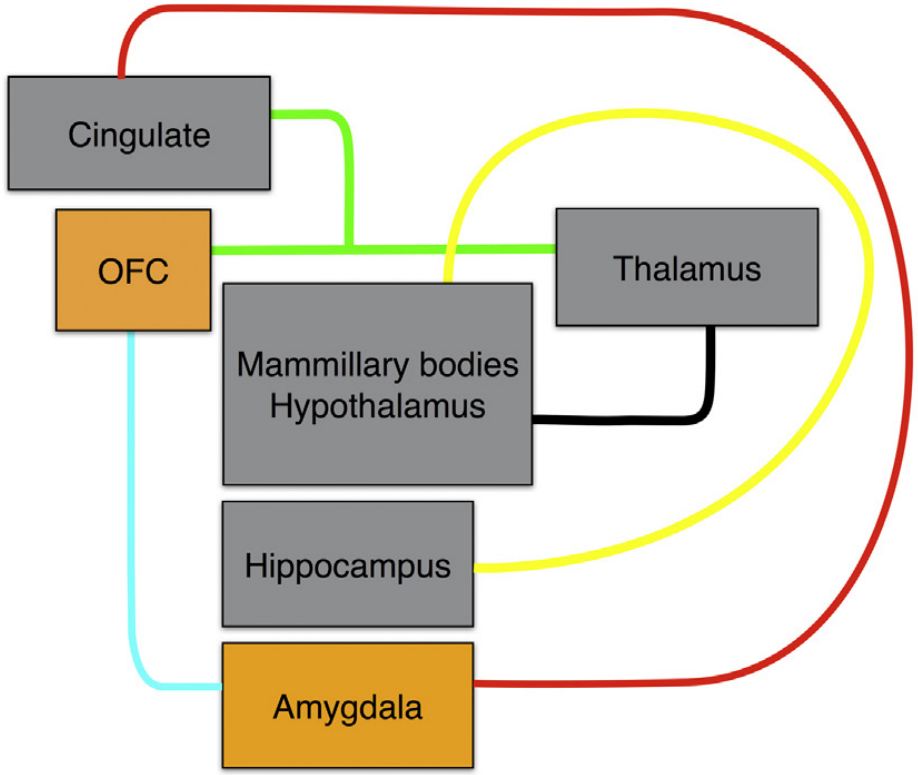
Background: The Fornix

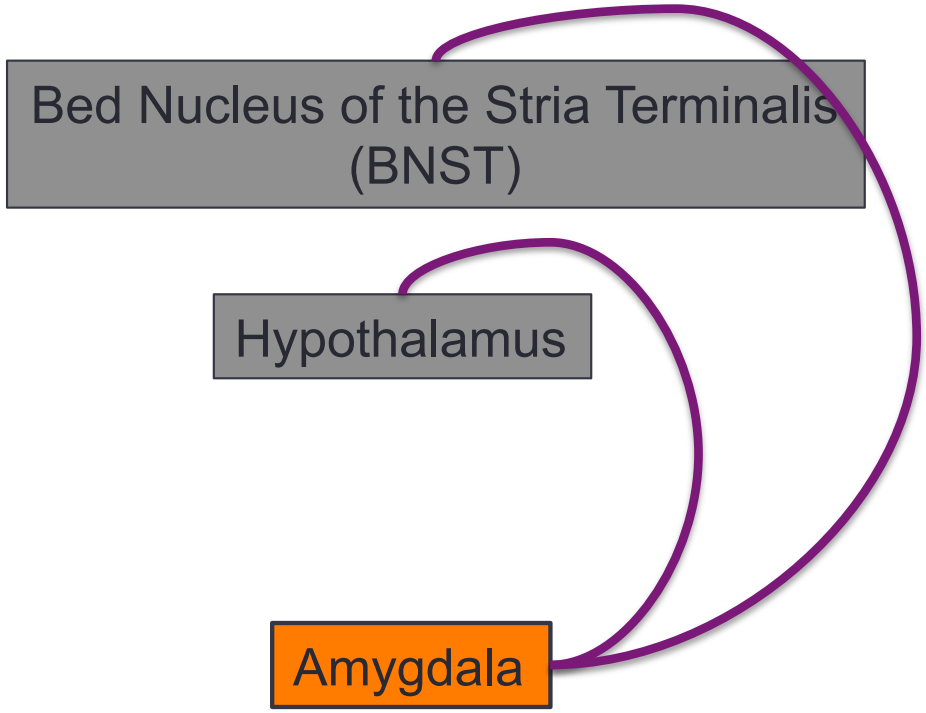




Catani et al. 2013

Background: Another limbic bundle -- Stria Terminalis

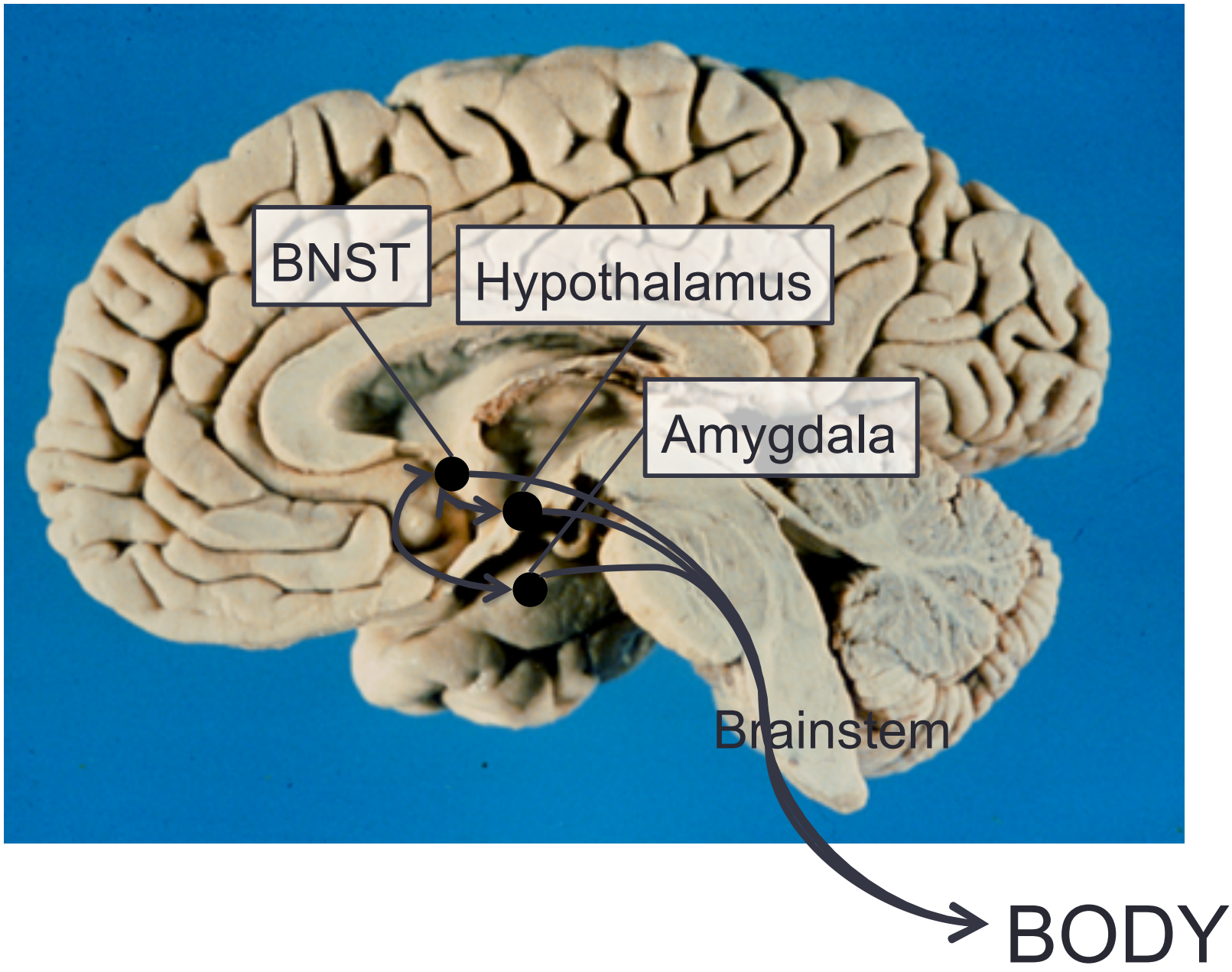




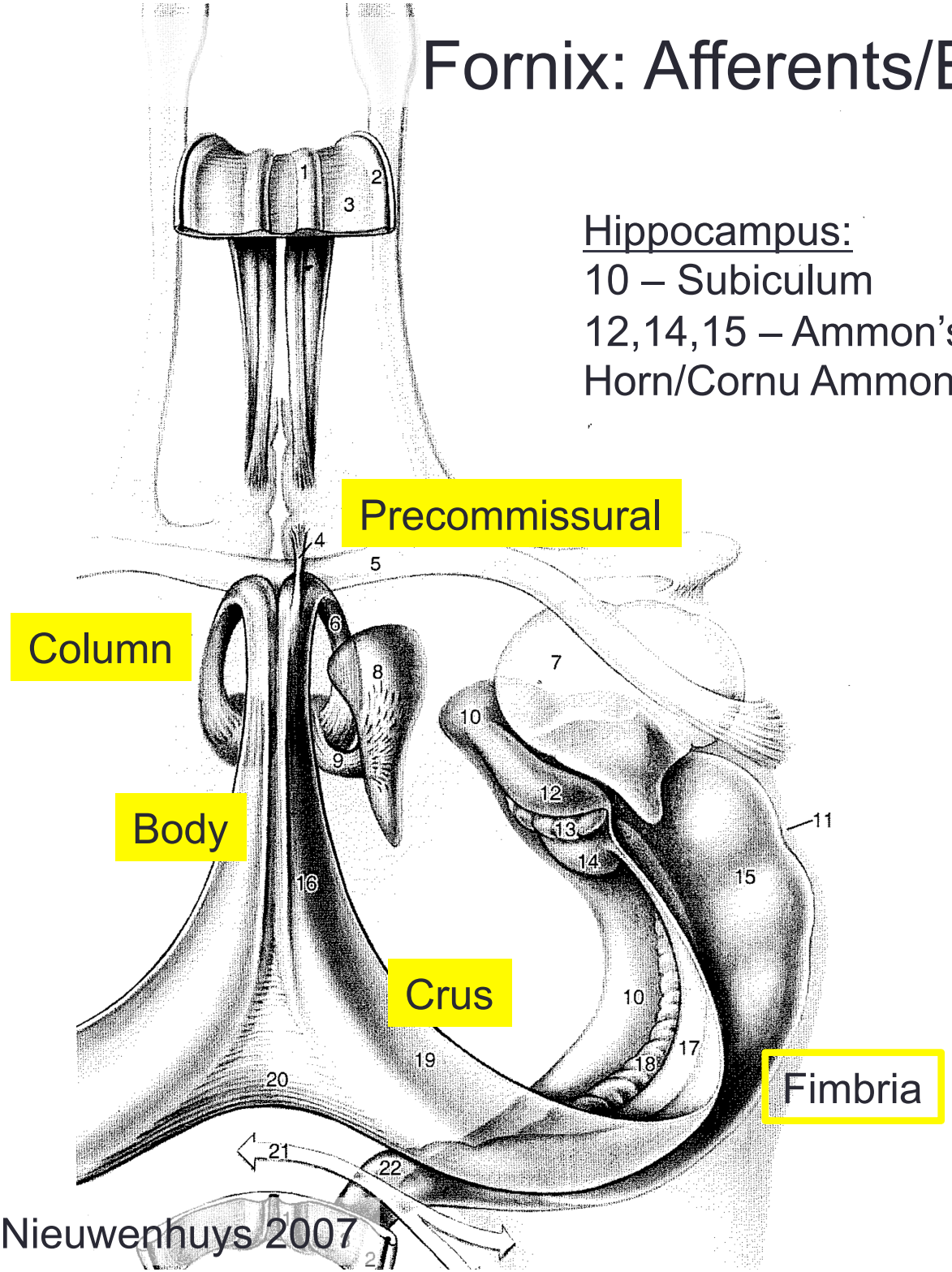
Catani et al. 2013

Stria Terminalis

Background: BNST is Visceral, too

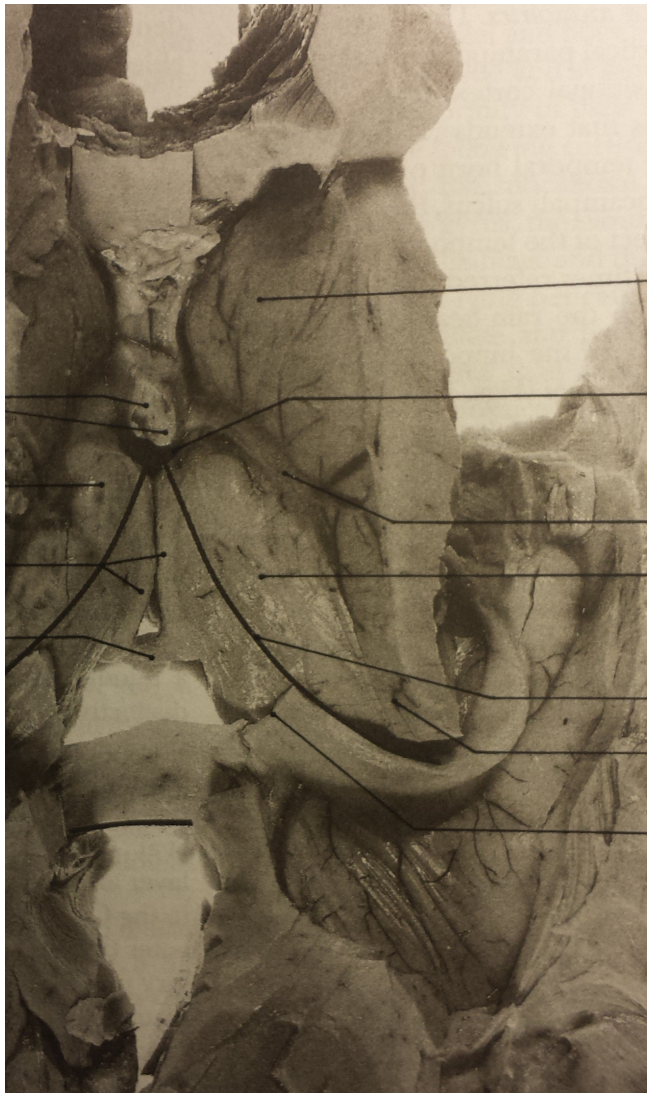


Fornix: Afferents/Efferents



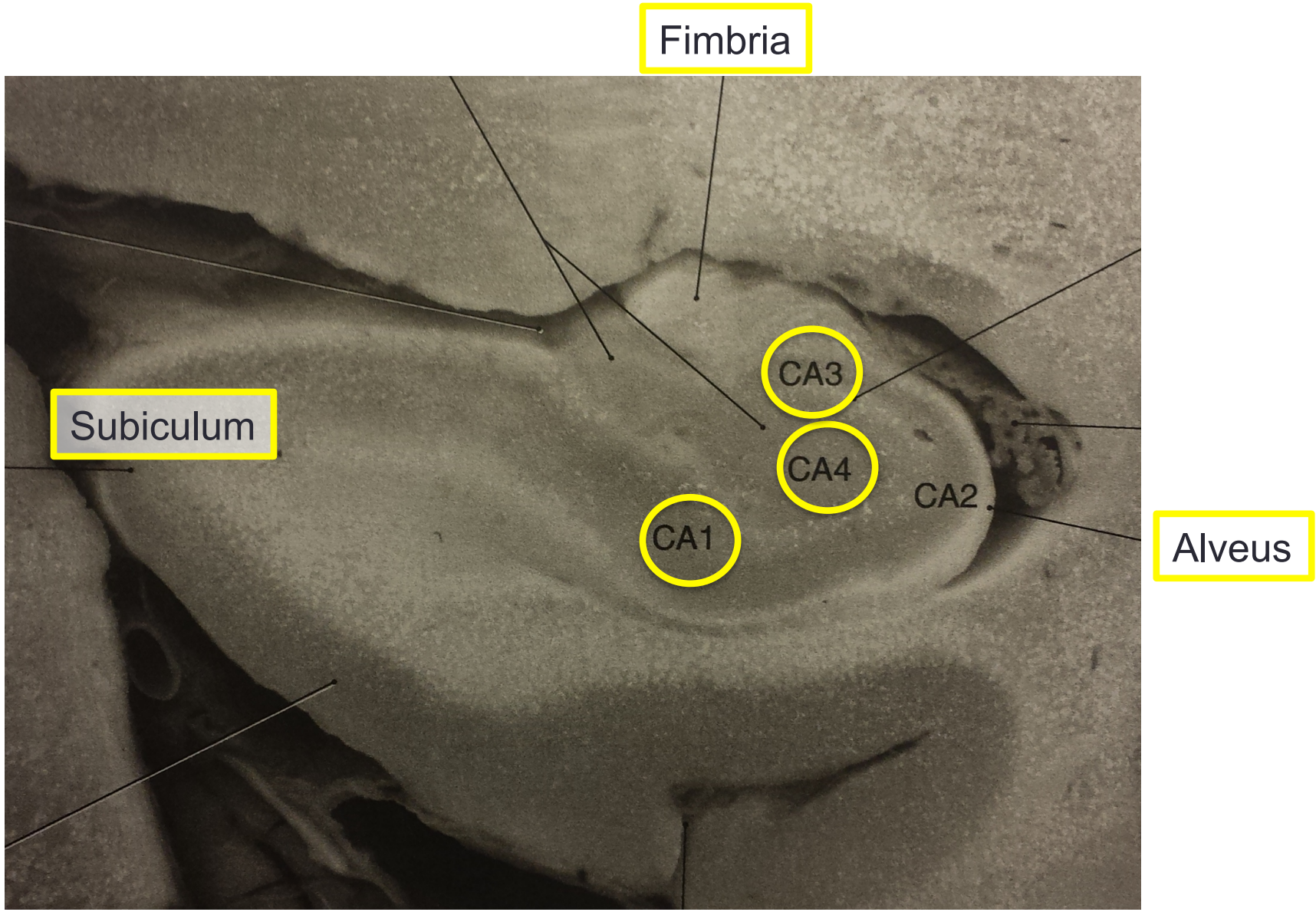
Nieuwenhuys 2007

Hippocampus:
10 – Subiculum
12,14,15 – Ammon's Horn/Cornu Ammonis



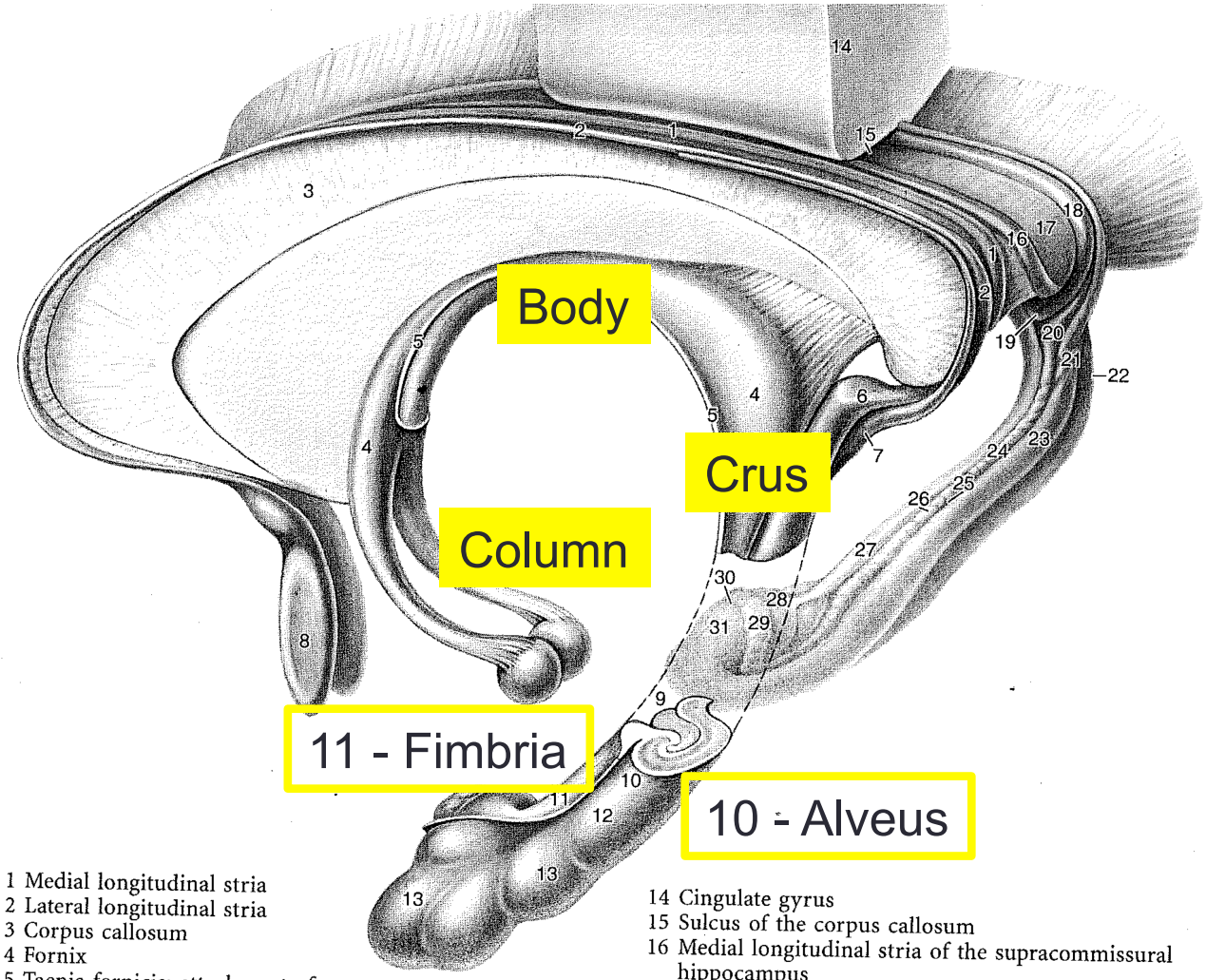
Bruni and Montemurro 2009

Fornix: Afferents/Efferents



Bruni and Montemurro 2009

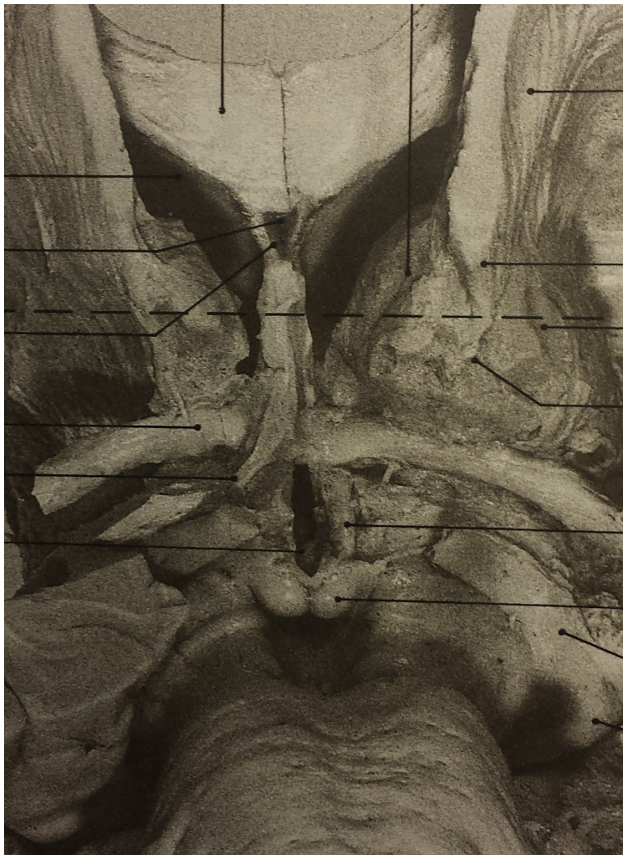
Fornix: Afferents Efferents



1 Medial longitudinal stria
2 Lateral longitudinal stria
3 Corpus callosum
4 Fornix
5 Taenia fornicis: attachment of the choroid plexus to the fornix

14 Cingulate gyrus
15 Sulcus of the corpus callosum
16 Medial longitudinal stria of the supracommissural hippocampus
17 Indusium griseum of the supracommissural hippo-

Nieuwenhuys 2007

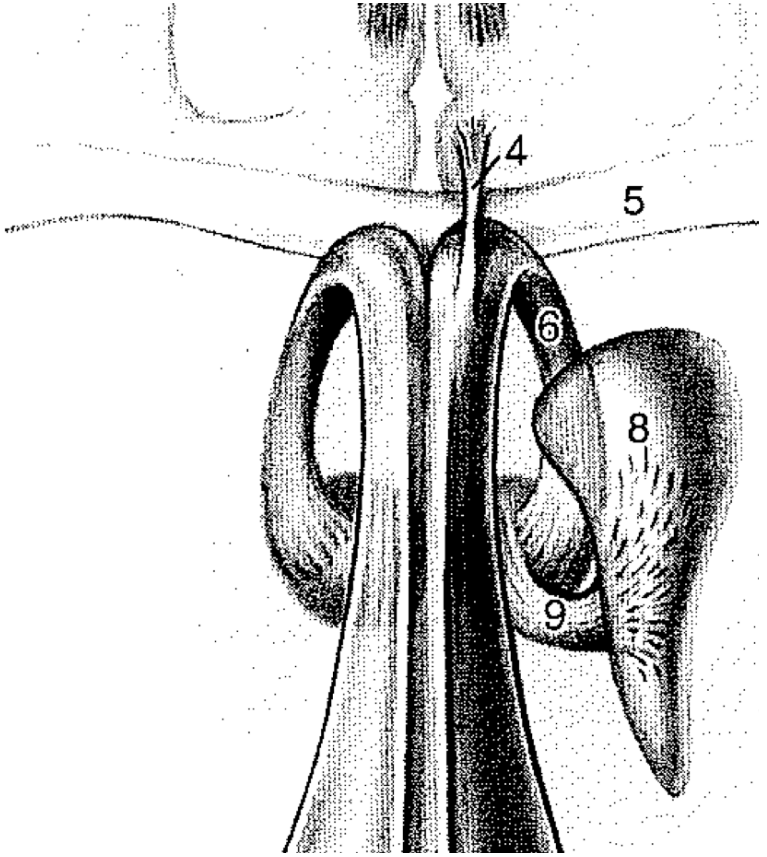


Bruni and Montemurro 2009

Fornix: Afferents/Topography

1. Precommissural fornix – septal area, basal and medial forebrain, hypothalamic areas

2. Postcommissural fornix – mammillary bodies; anterior and midline thalamus; bed nucleus of the stria terminalis



Nieuwenhuys 2007

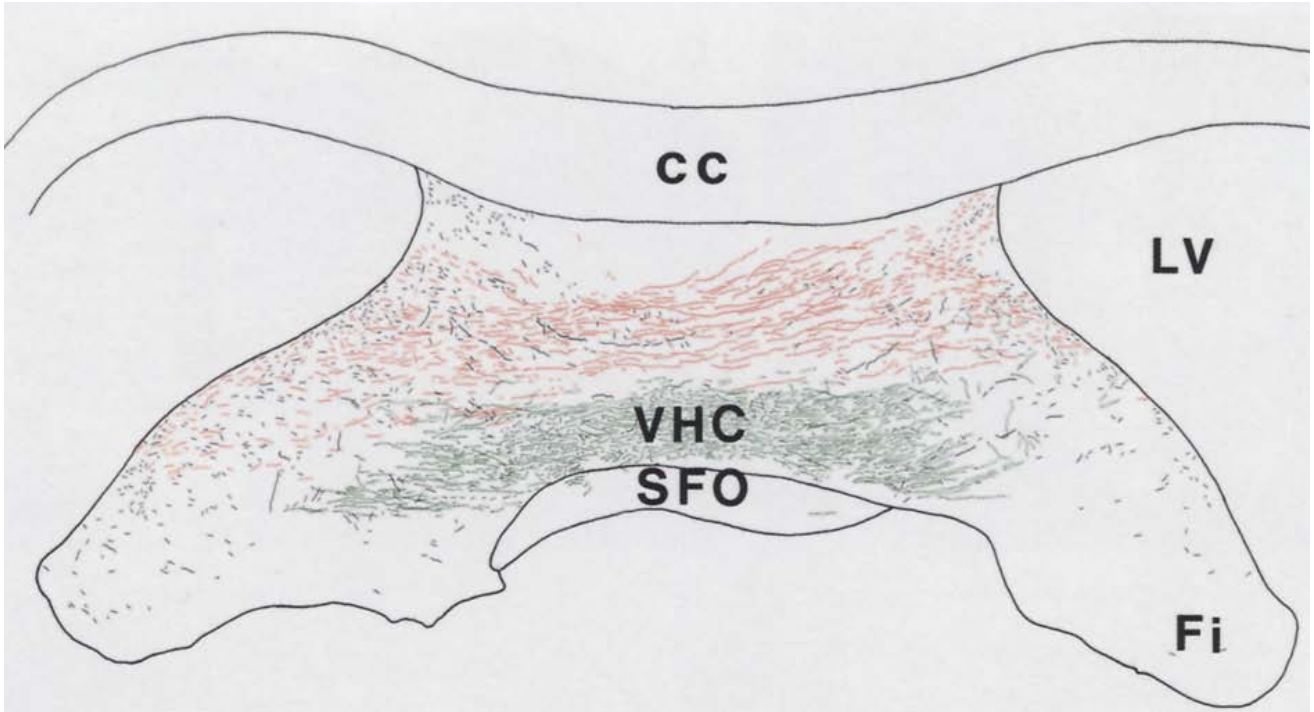
Fornix: Afferents/Topography

1. Septo-hippocampal (precommissural fornix) - ventricular

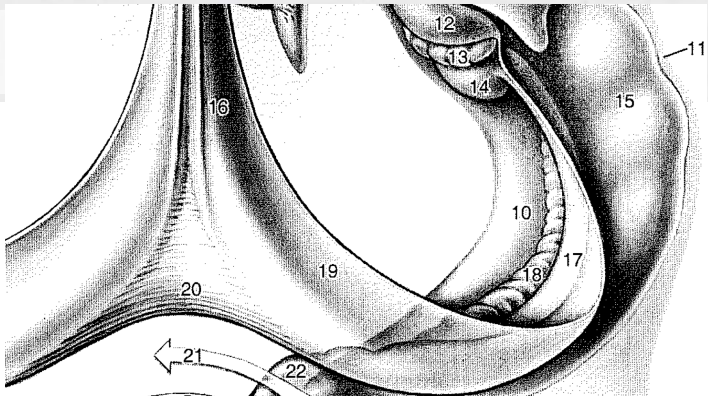
2. Commissural projections (dentate gyrus/CA3 efferents) – ventral hippocampal commissure (VHC)/ pial surface

3. Entorhinal cortex (crossed) - ventricular

Fornix

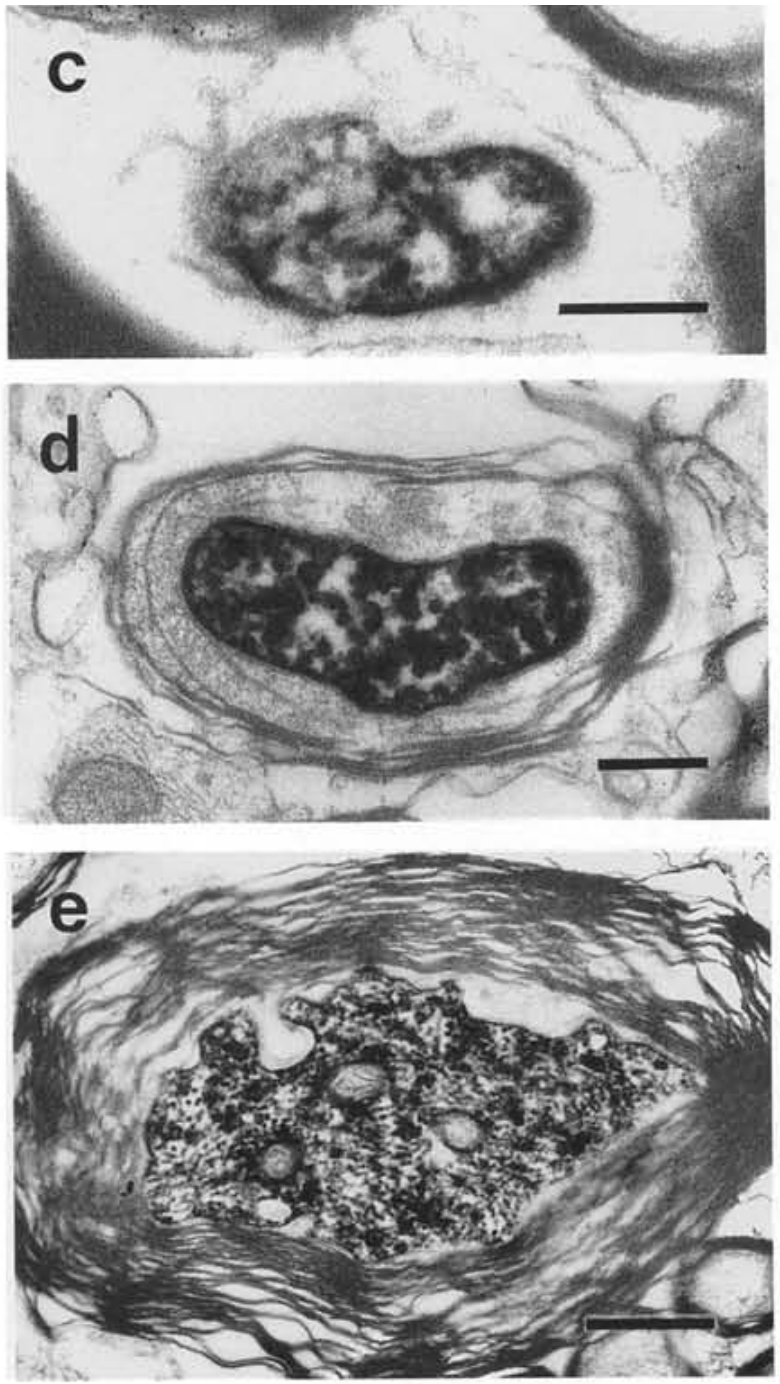


Adelmann et al. 1996



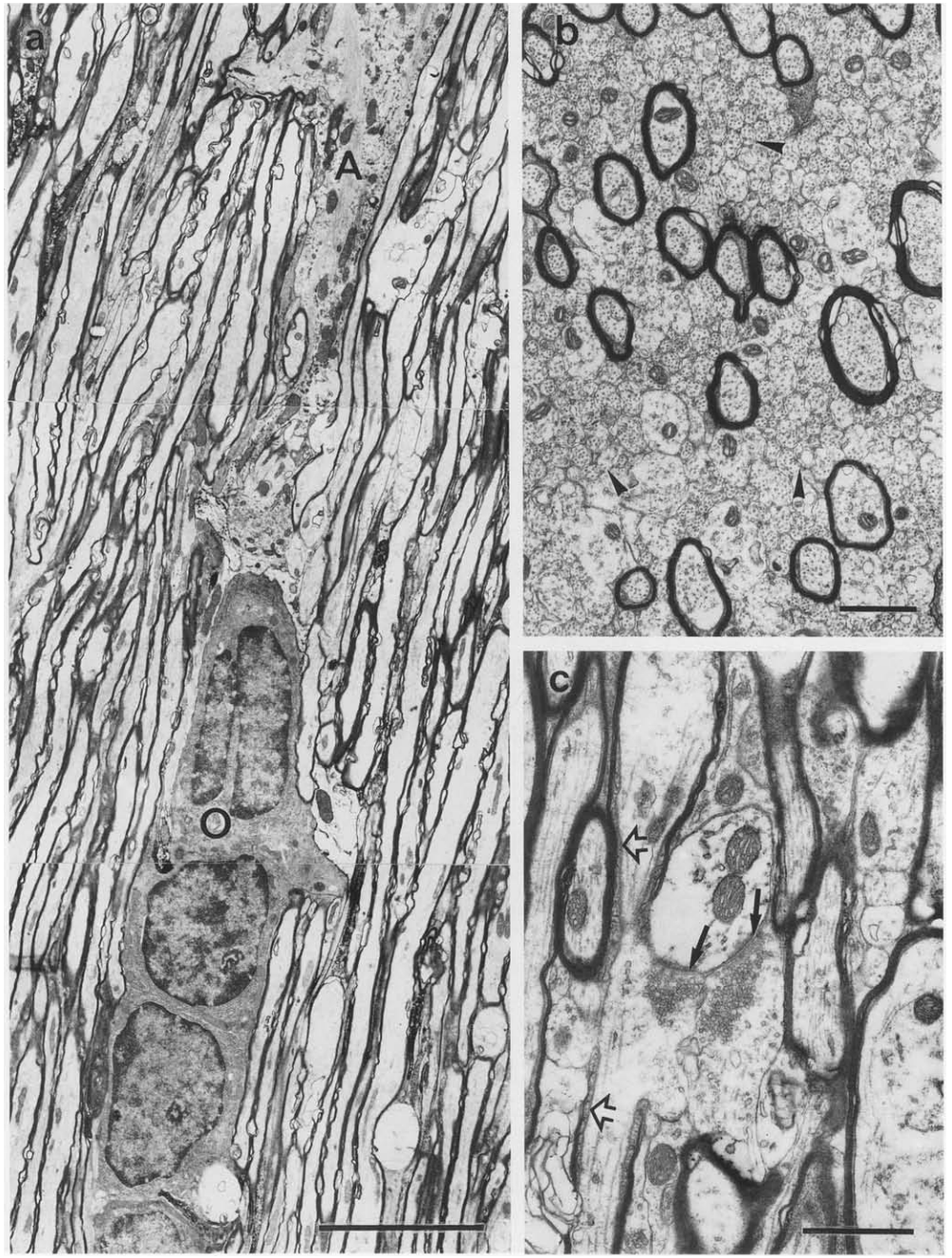
Nieuwenhuys 2007

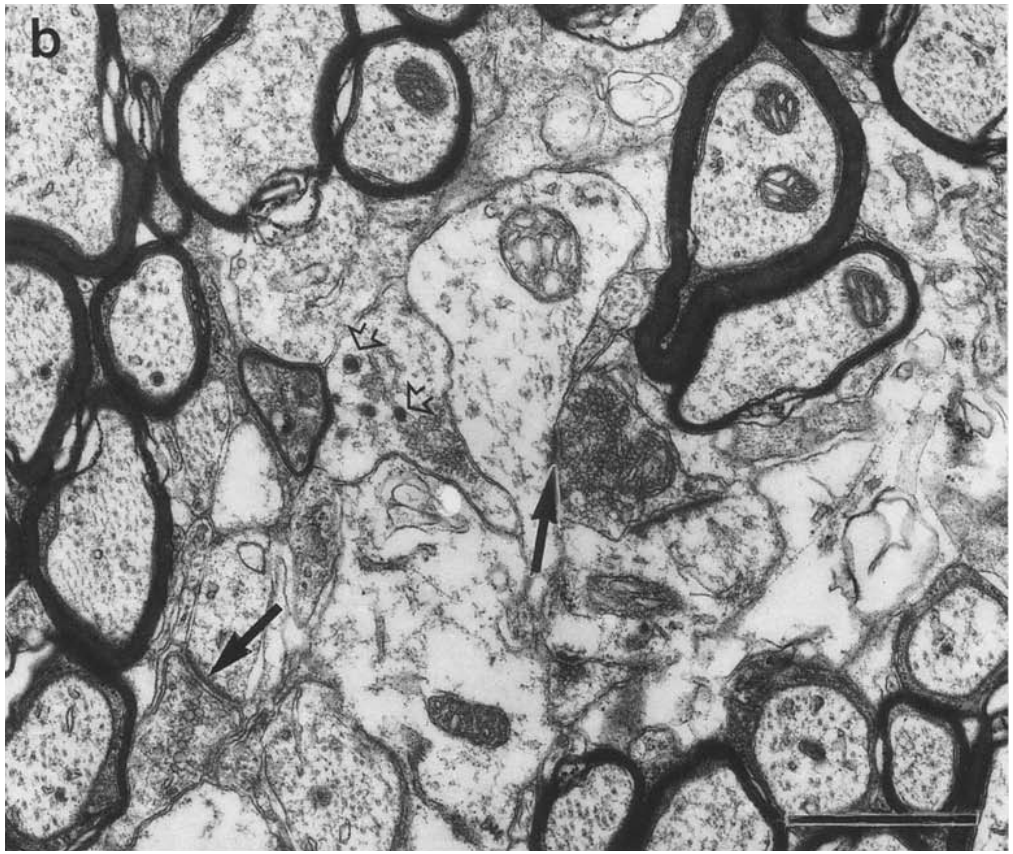
Fornix: Neurophysiology/Neurochemistry



Adelmann et al. 1996

Fornix: Neurophysiology/Neurochemistry



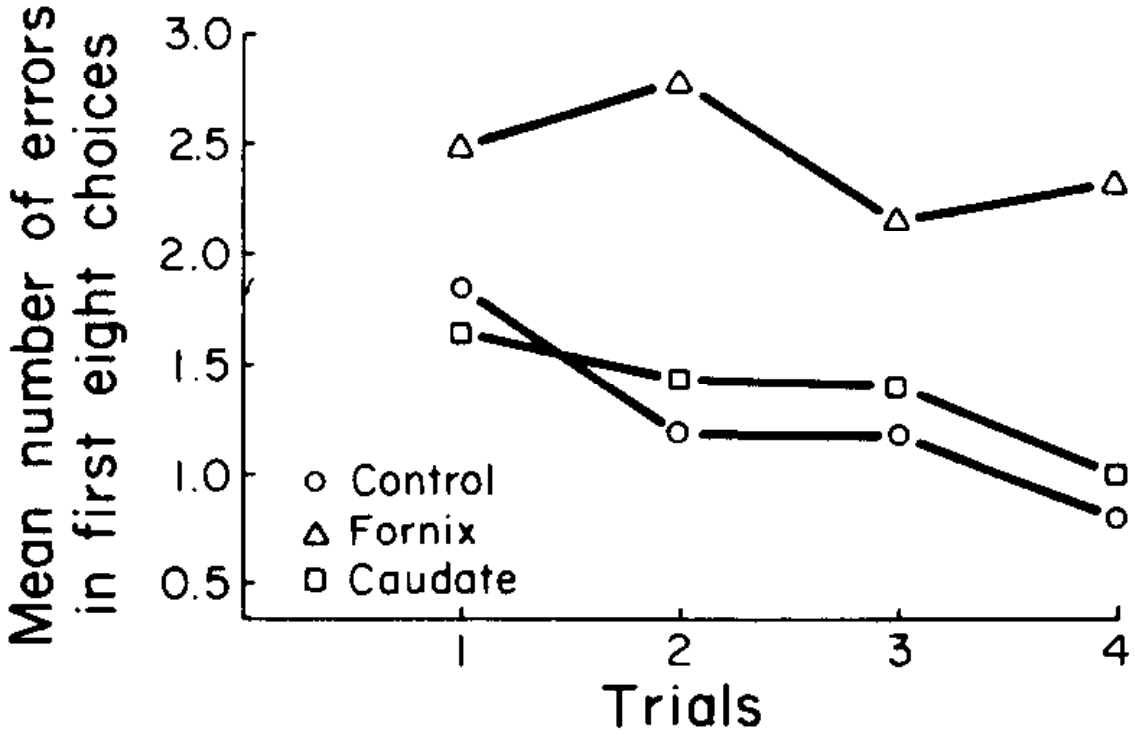


Adelmann et al. 1996

Fornix: Behavioral Correlates

Memory

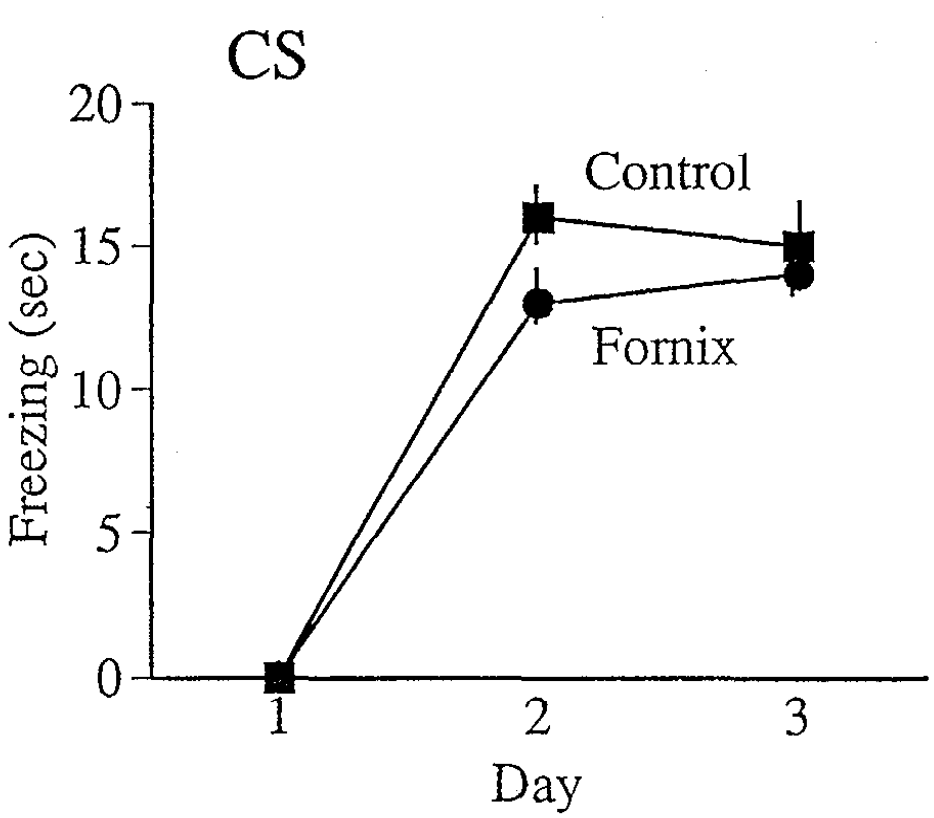
Fornix appears to be necessary for memory (acquisition and retention).
(Sutherland and Rodriguez 1989, Galani 2002, Cassel 1998, Nilsson 1987)

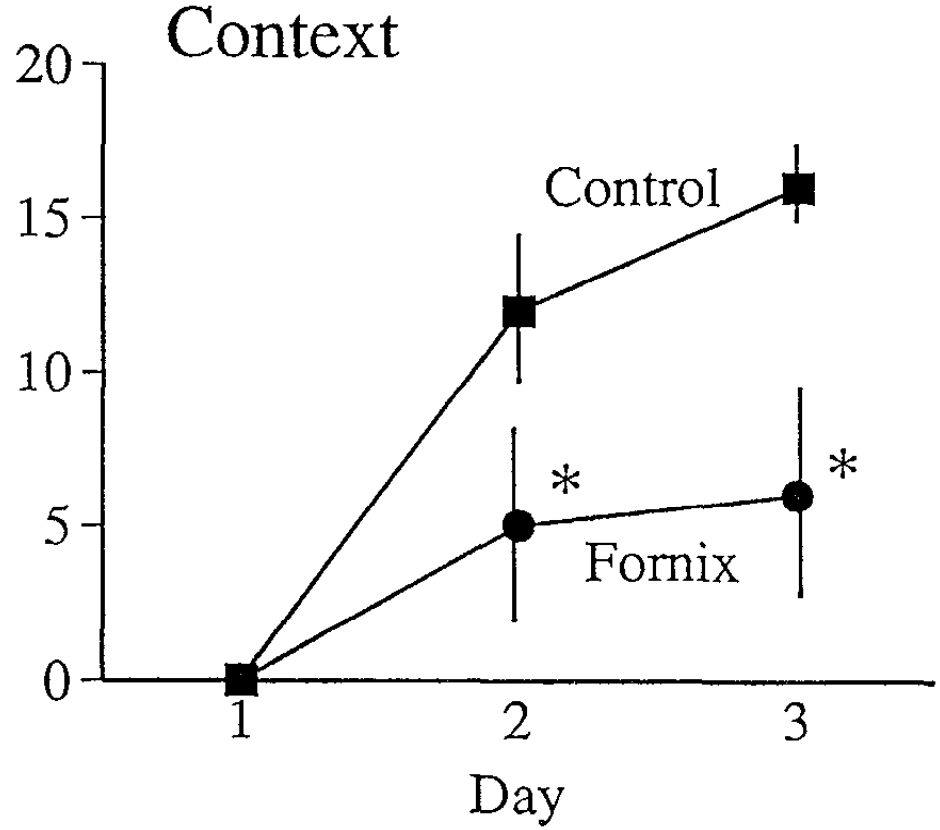


Packard et al. 1989

Fornix: Behavioral Correlates

Fear Conditioning



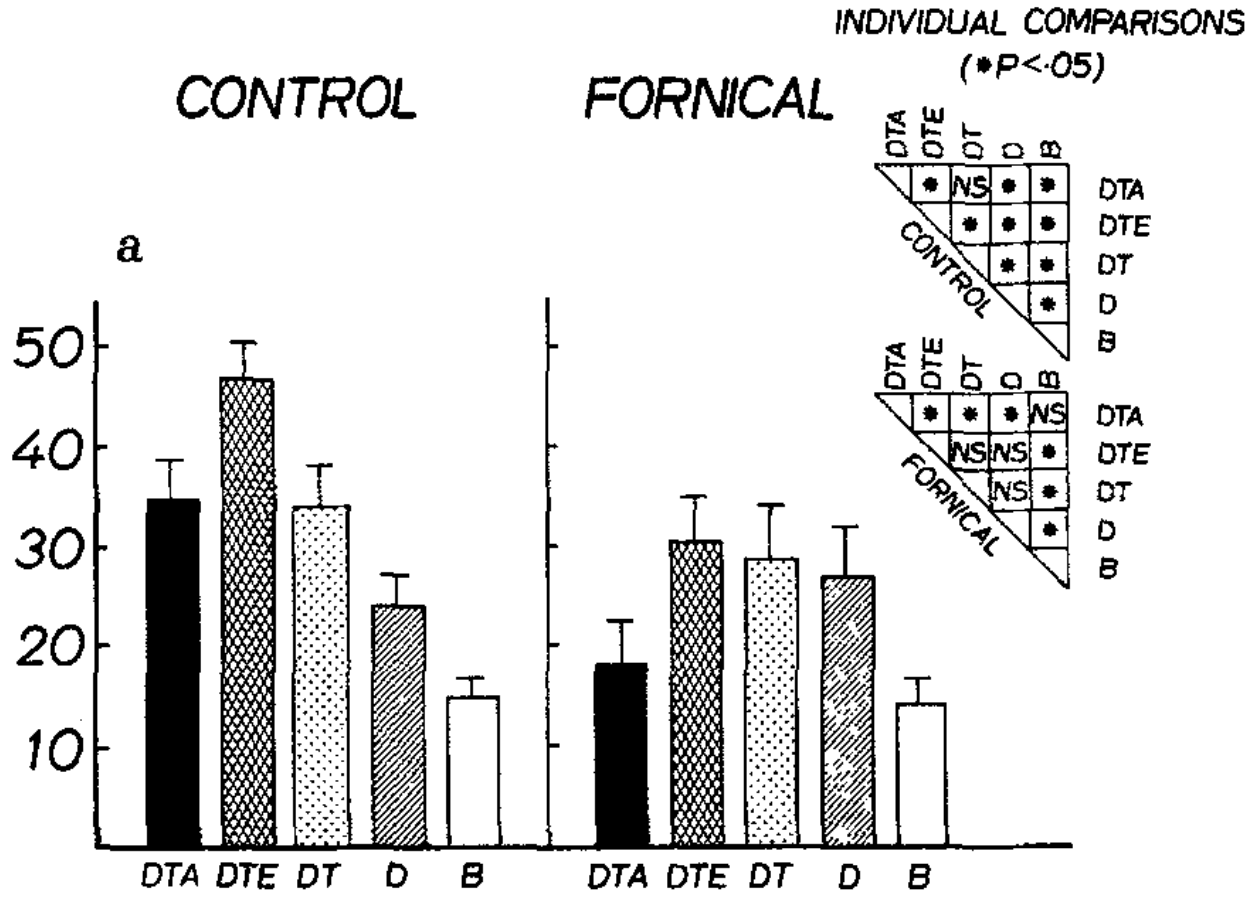


Phillips and LeDoux 1995

Fornix: Physiological Correlates

Corticosterone (Neuroendocrine) Response to Operant Conditioning

Plasma Corticosterone ug/100mL

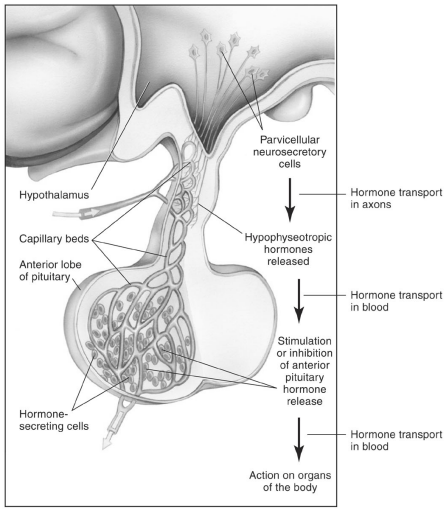


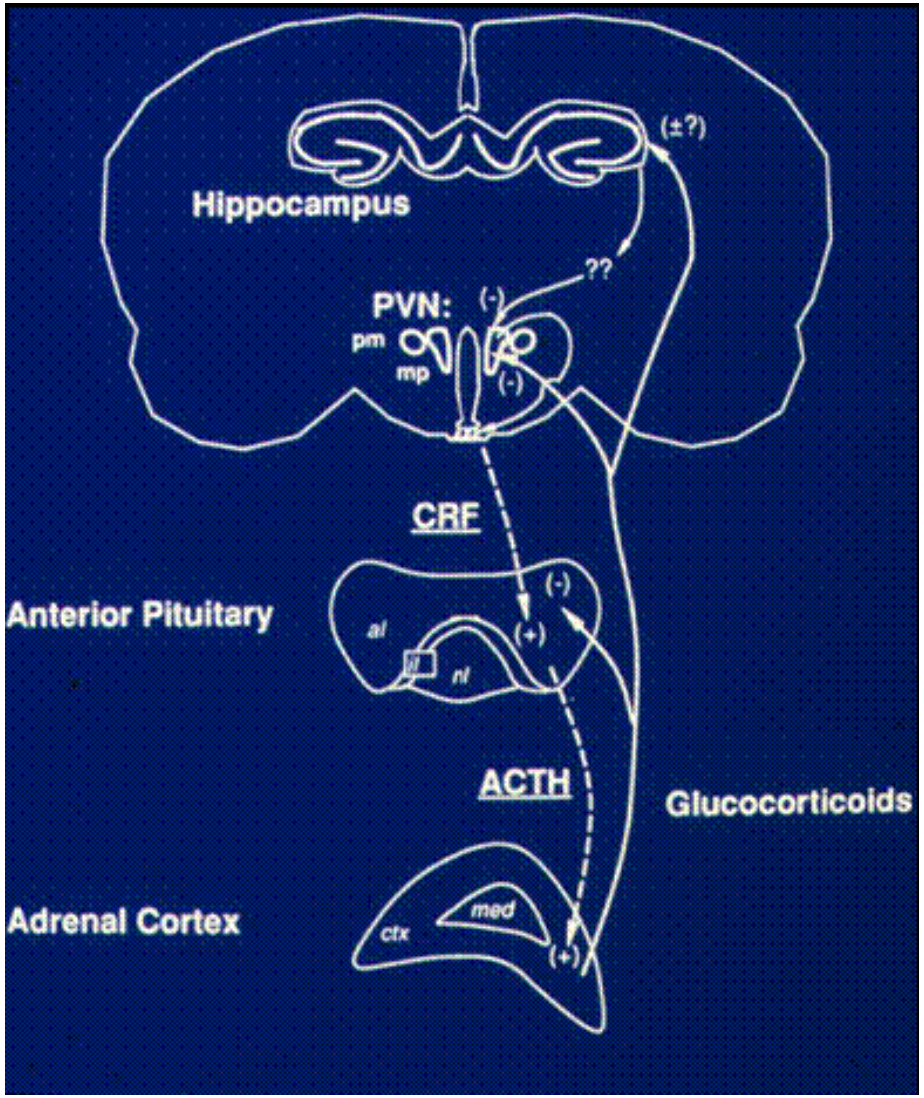
Fornix: Physiological Correlates

- Stimulation in humans with involuntary movement problems (Doi et al. 1968)
  - ~2 degree decrease in body temperature
  - Flushing/perspiration
  - Dilated pupils
- Stimulation of dorsal fornix in rabbits (Cragg and Hamlyn 1959)
  - Decreased blood pressure
  - Increased respiration

Fornix: Physiological Correlates

Fornix transection made rats resistant to high glucocorticoid feedback signal (Sapolsky et al. 1989)



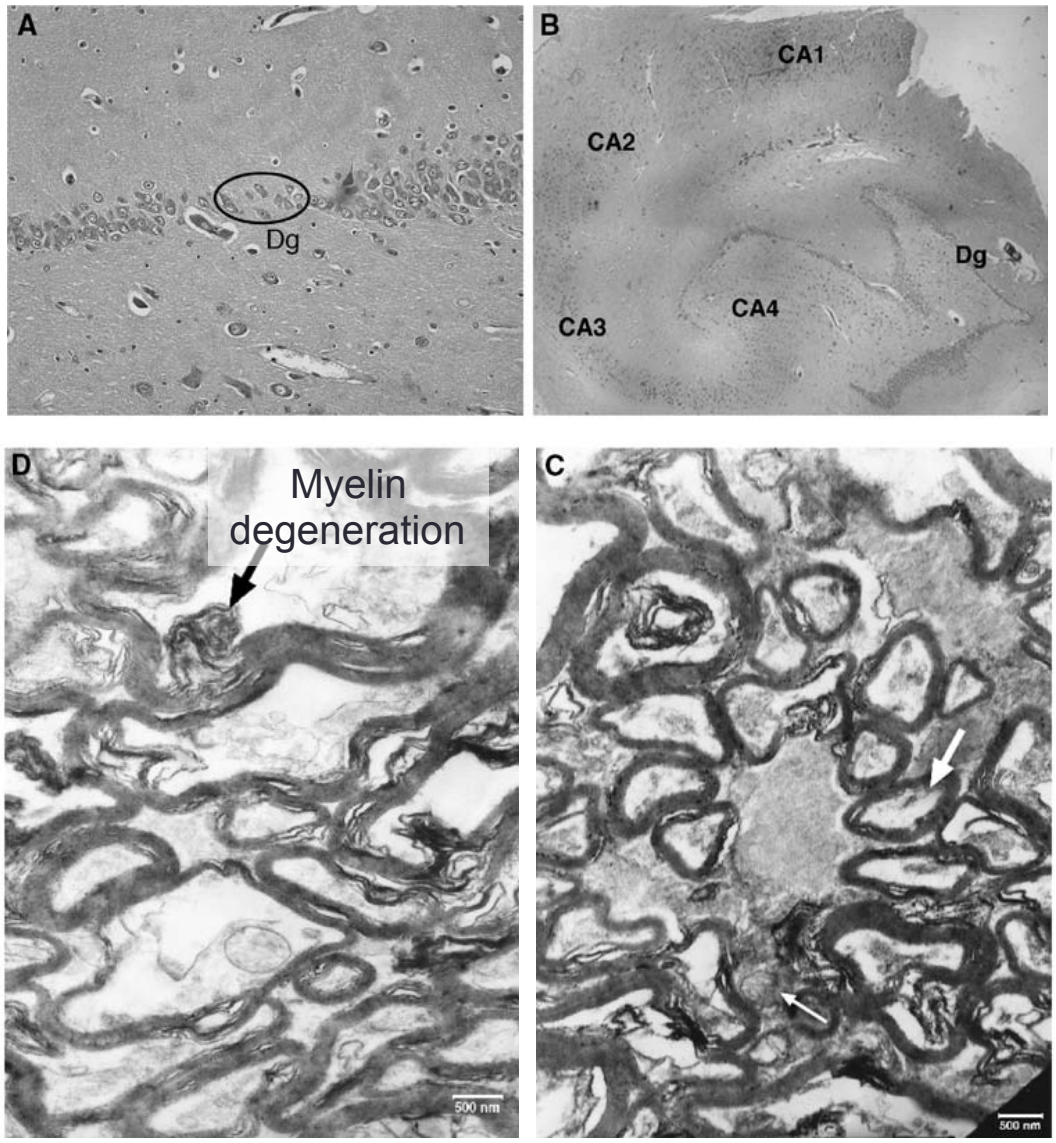


Fornix: Clinical Pathologies

Temporal Lobe Epilespy

Epilepsy patient

Normal autopsy

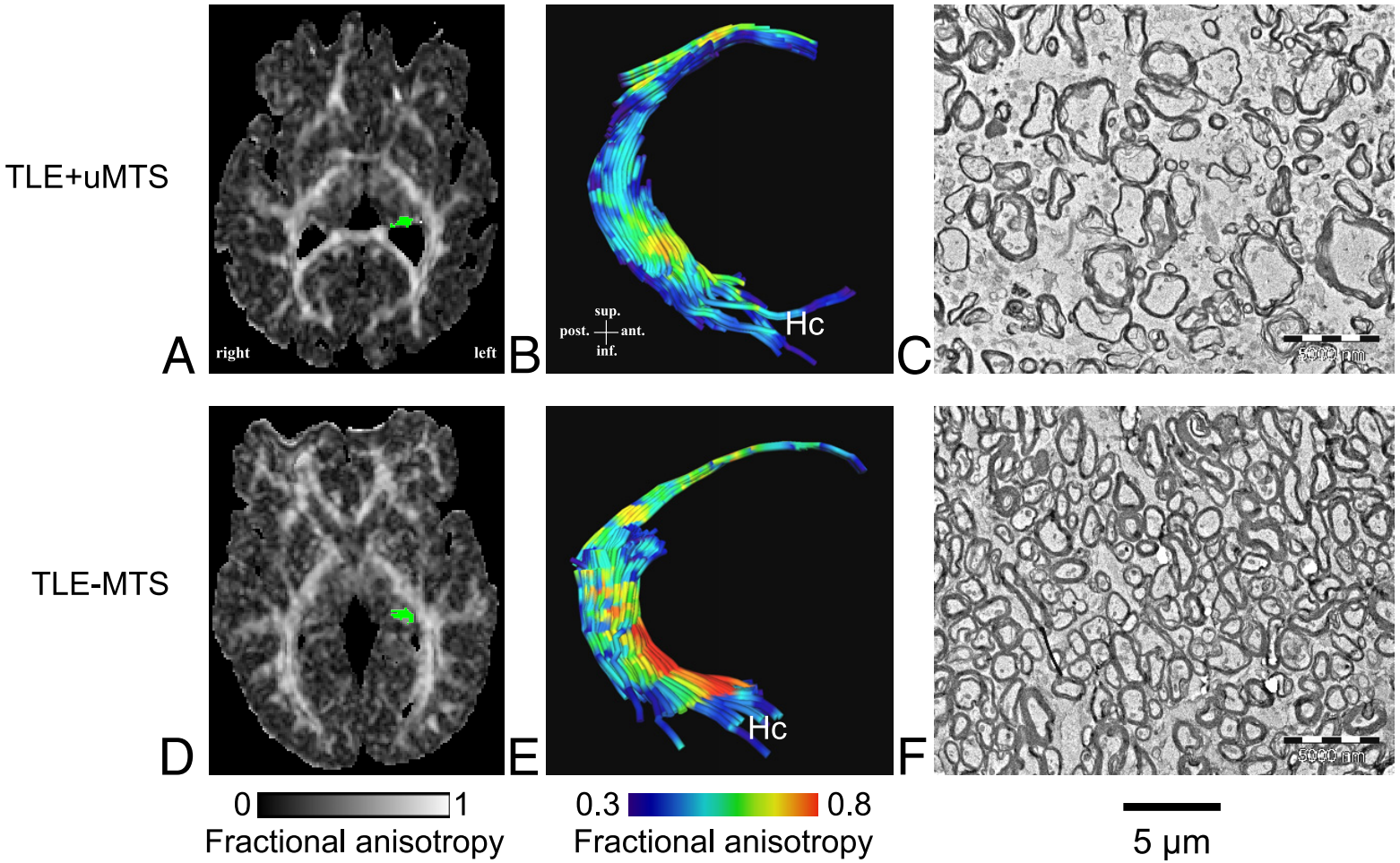


Fornix

Ozdogmus et al. 2009

Fornix: Clinical Pathologies

Temporal Lobe Epilespy/Mesial Temporal Sclerosis



Concha et al. 2010

Fornix: Clinical Pathologies

Cognitive Deficits: Alzheimer Disease

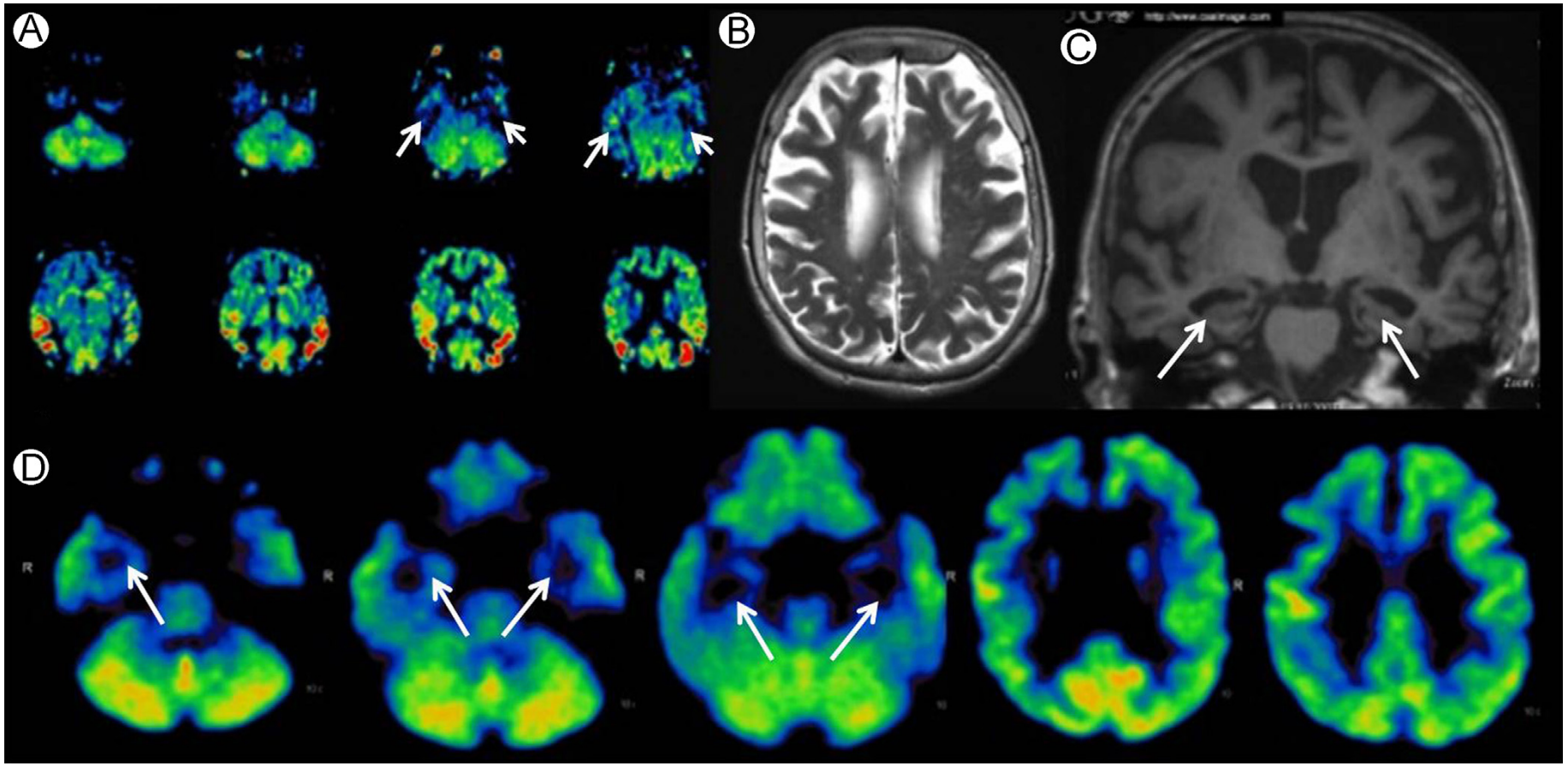
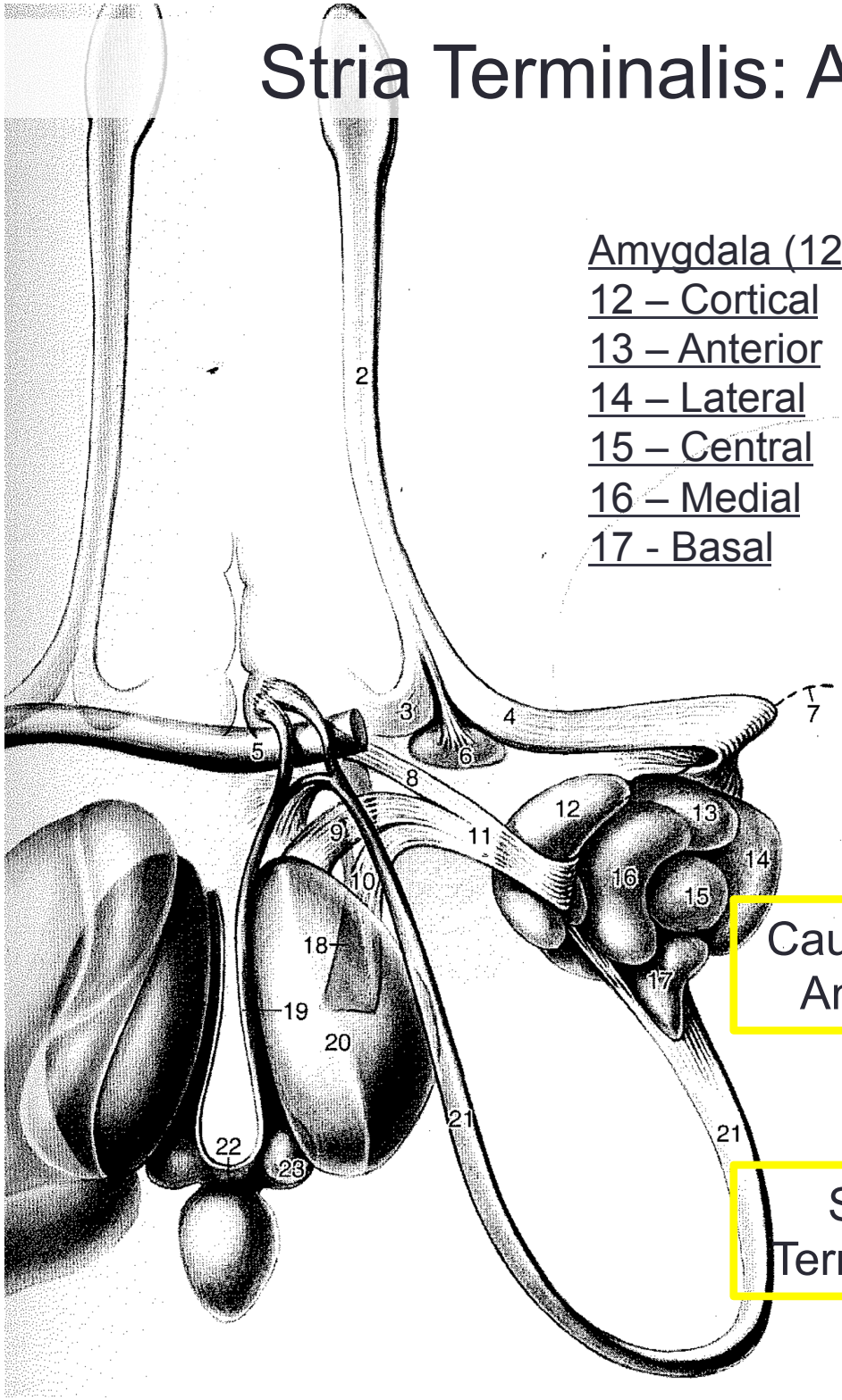


Figure 17 Alzheimer disease: (A) series of ^{18}FDG-PET images showing bilateral temporal lobe hypoperfusion (arrows); (B) axial T2-weighted image of the brain showing diffuse cortical atrophy; (C) coronal T1 image showing advanced bilateral hippocampal atrophy (arrows); (D) arterial spin-labeling (ASL) perfusion imaging also shows the temporal lobe hypoperfusion (arrows). ^{18}FDG-PET, fludeoxyglucose-positron emission tomography.

Lovblad et al. 2014

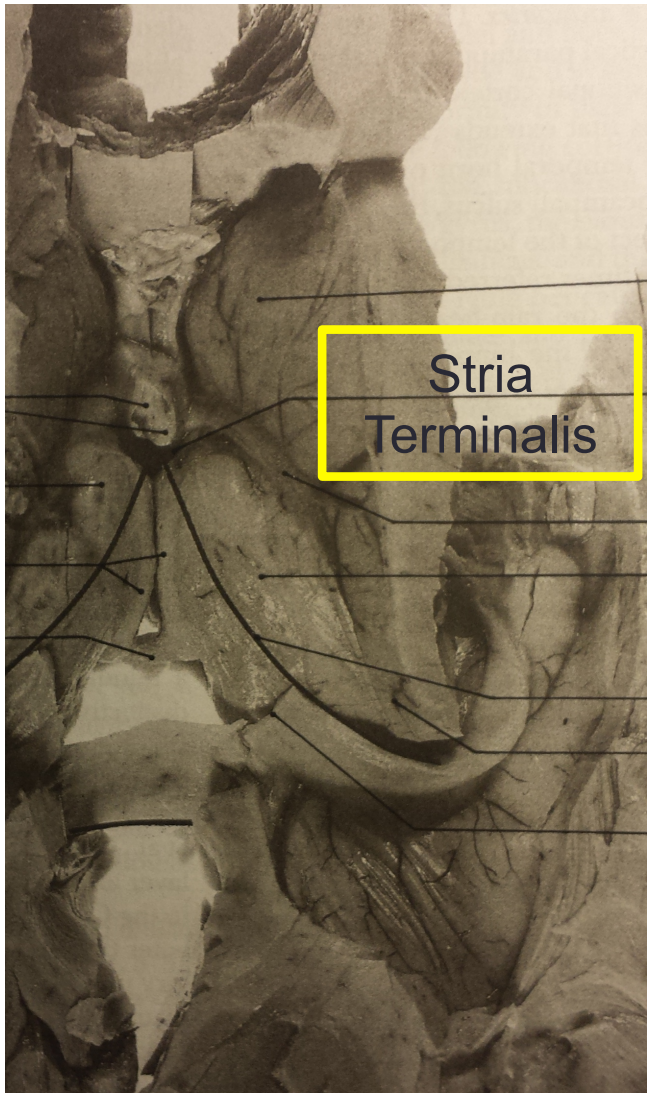
Stria Terminalis: Afferents/Efferents



Amygdala (12-17):
12 – Cortical
13 – Anterior
14 – Lateral
15 – Central
16 – Medial
17 - Basal

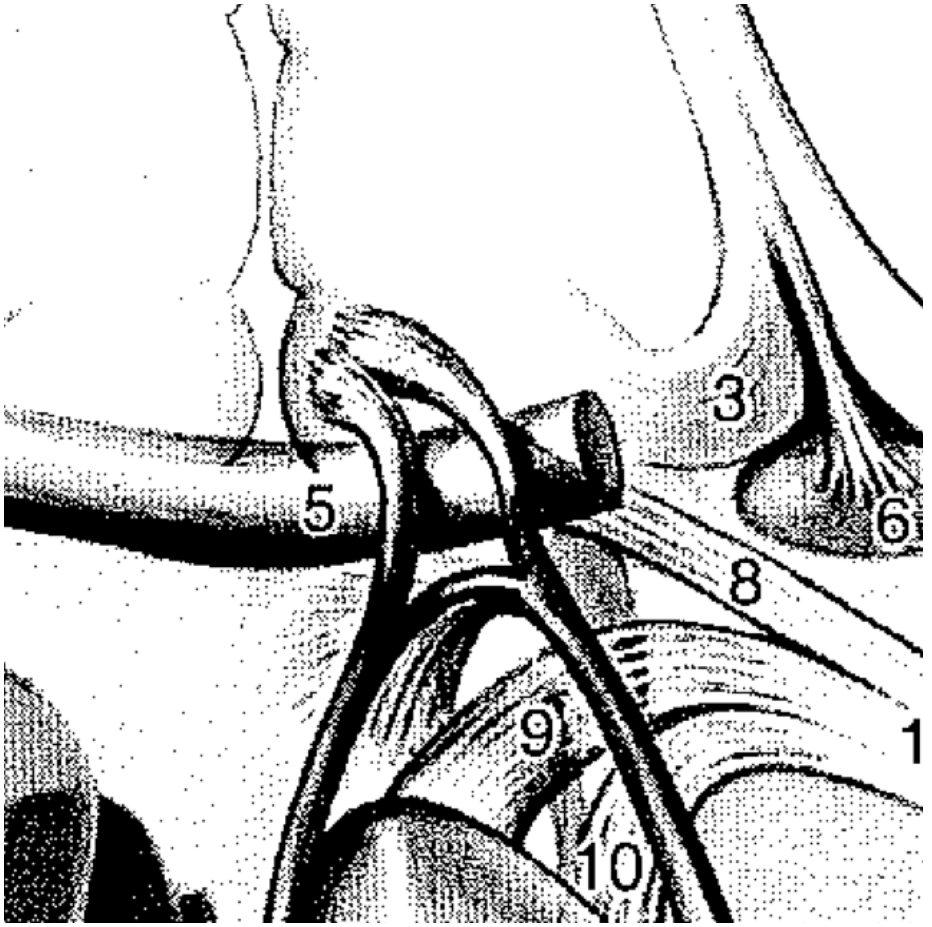
Caudomedial Amygdala

Stria Terminalis

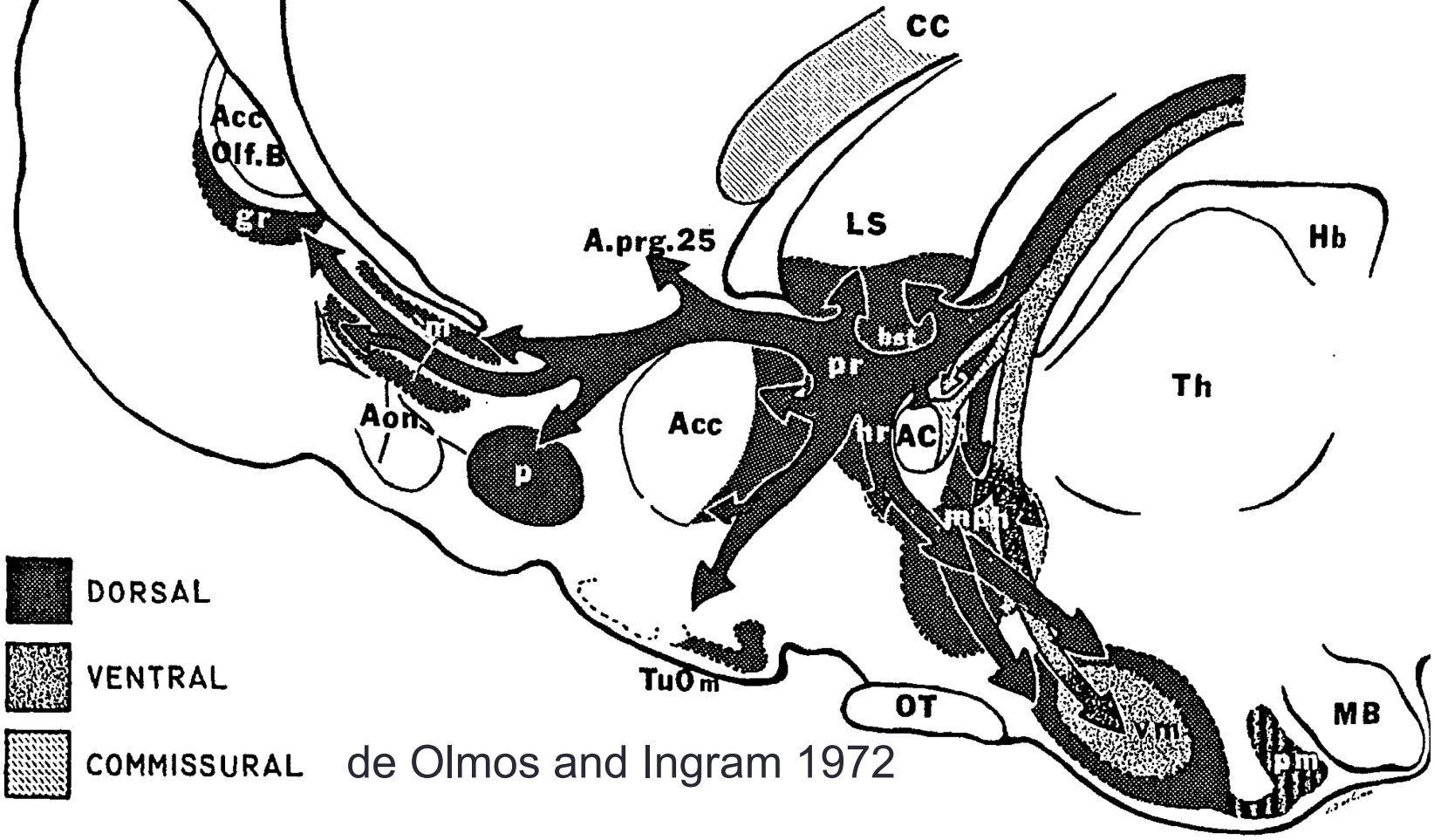


Stria Terminalis: Afferents/Topography

1. Precommissural/ supracommissural/dorsal
2. Commissural
3. Postcommissural/ preoptic/ventral



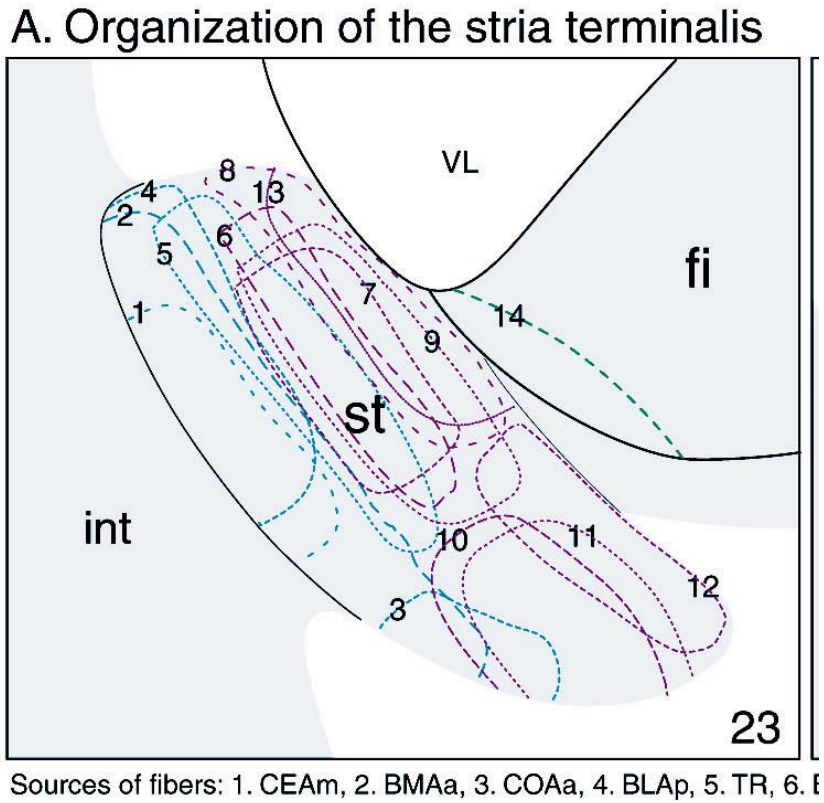
Stria Terminalis: Afferents/Topography



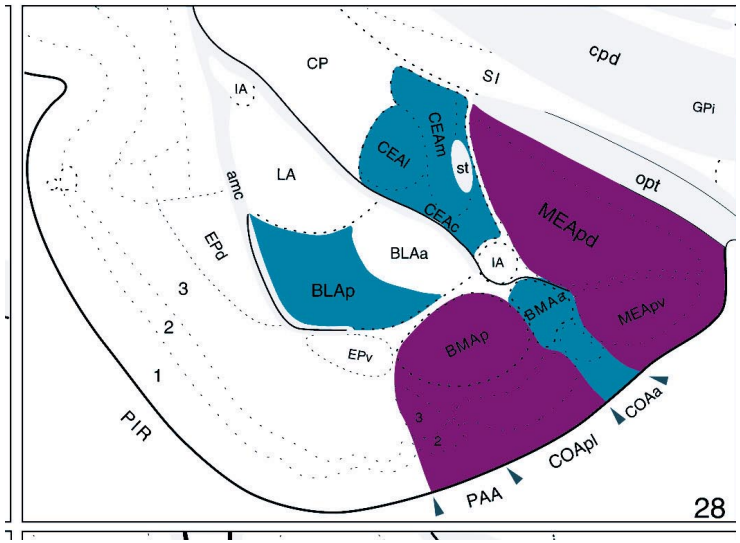
de Olmos and Ingram 1972

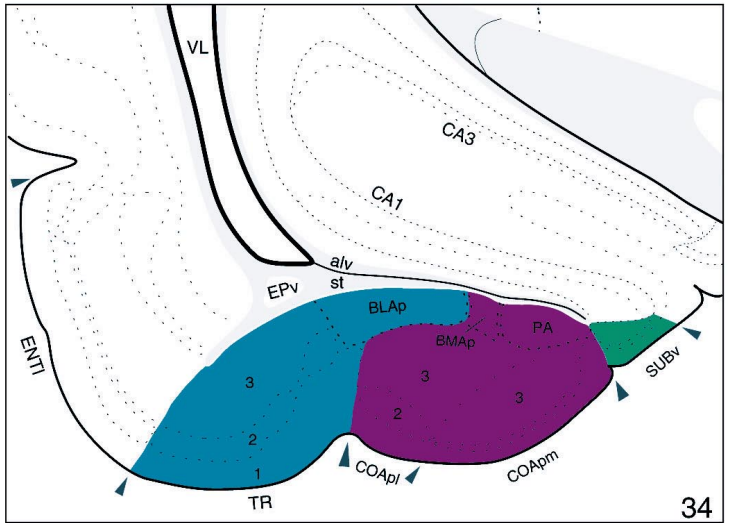
1. Precommissural/supracommissural/dorsal – olfactory areas, nucleus accumbens, BNST, ventromedial hypothalamus
2. Commissural – contralateral BNST
3. Postcommissural/preoptic/ventral – ventromedial hypothalamus

Stria Terminalis: Topography, Amygdala-to-BNST

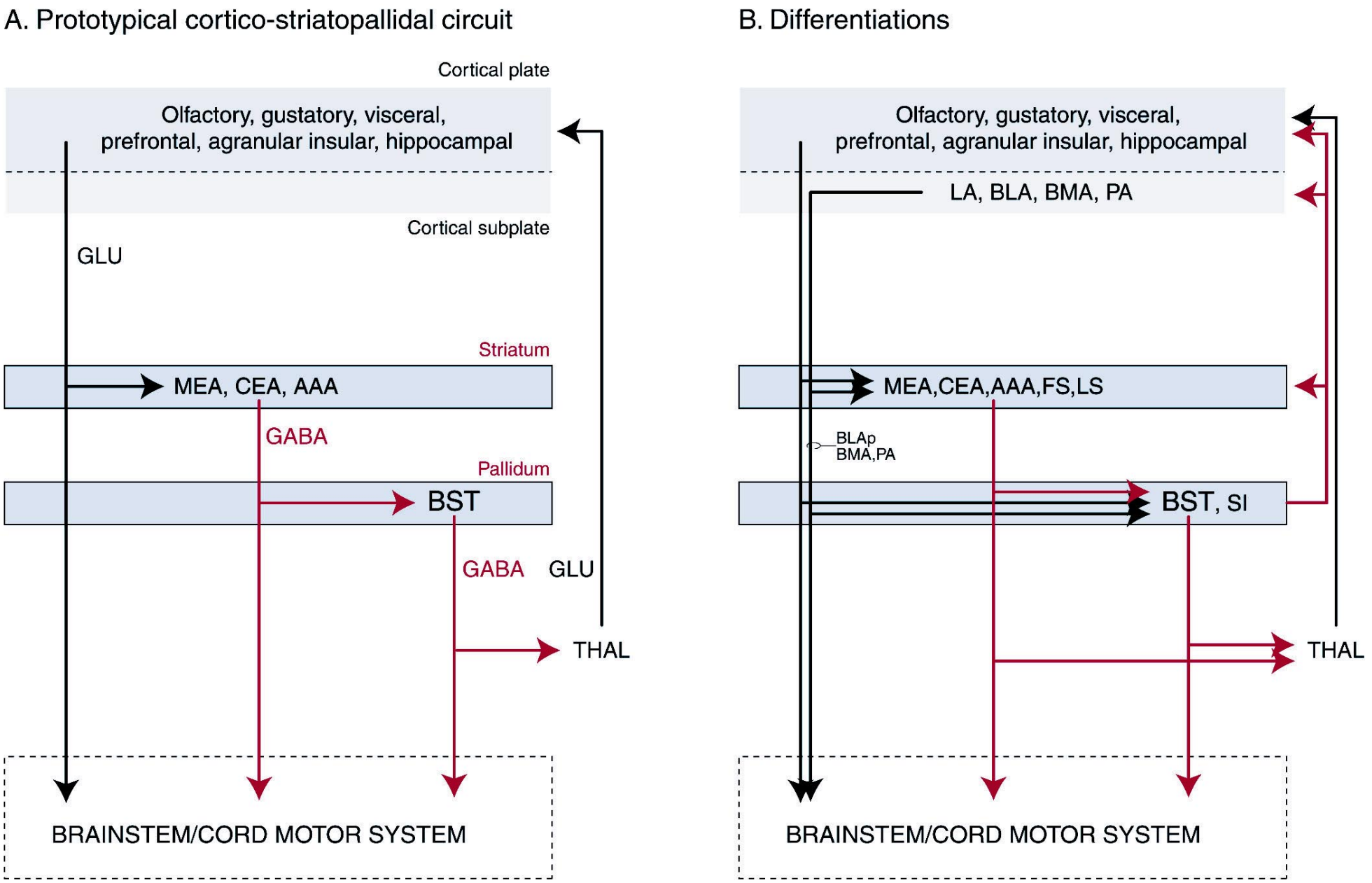


Dong and Swanson 2001





Stria Terminalis: Neurophysiology/Neurochemistry



Dong and Swanson 2001

Stria Terminalis: Neurophysiology/Neurochemistry

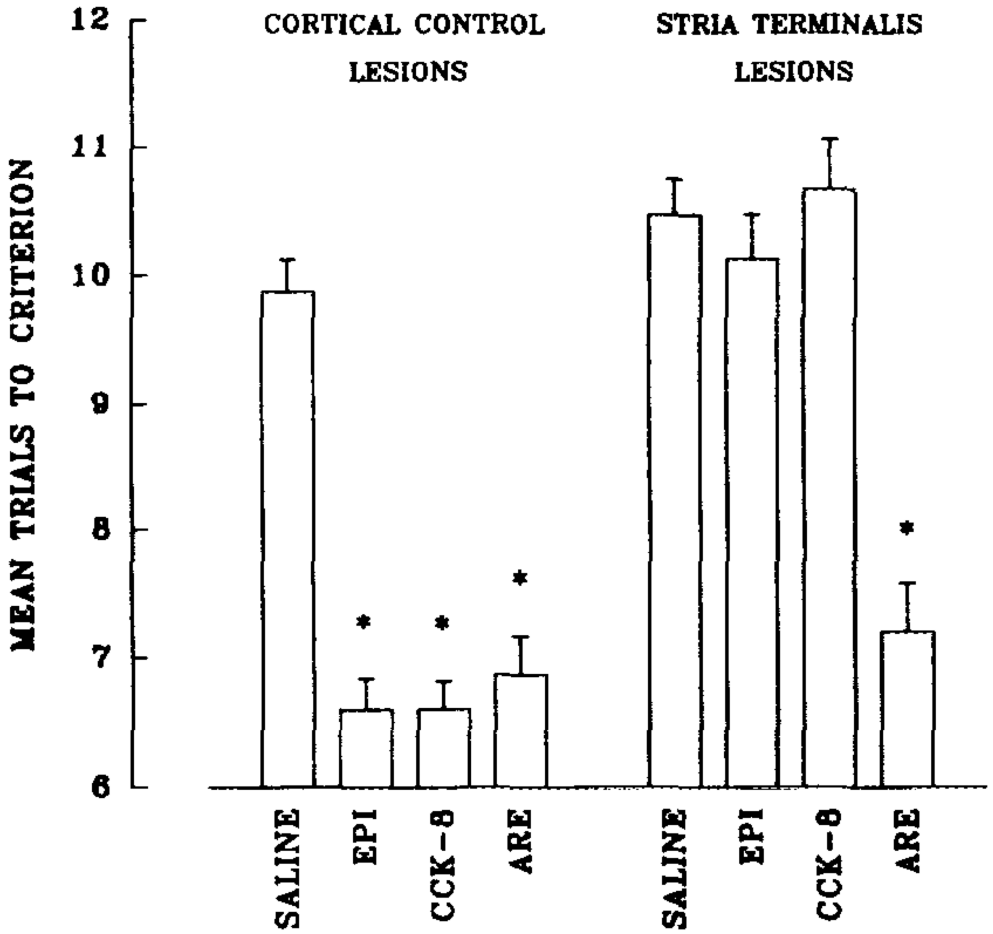
Neuropeptide-containing pathway:

- Enkephalin (Uhl 1978)
- Neuropeptide-Y (Allen 1984)
- Neutotensin (Uhl 1979)
- Sensitive to estrogen and testosterone (Takeo 1995, Kendrick 1979)

Stria Terminalis: Behavioral Correlates

Memory

When memory is modulated experimentally (epinephrine, glucocorticoids, cholecystokinin, etc.) ST lesions block or facilitate those effects (Torras-Garcia 1998, Packard 1996, Roozendaal 1996, Flood 1995)



Flood 1995

Stria Terminalis: Behavioral/Physiological Correlates

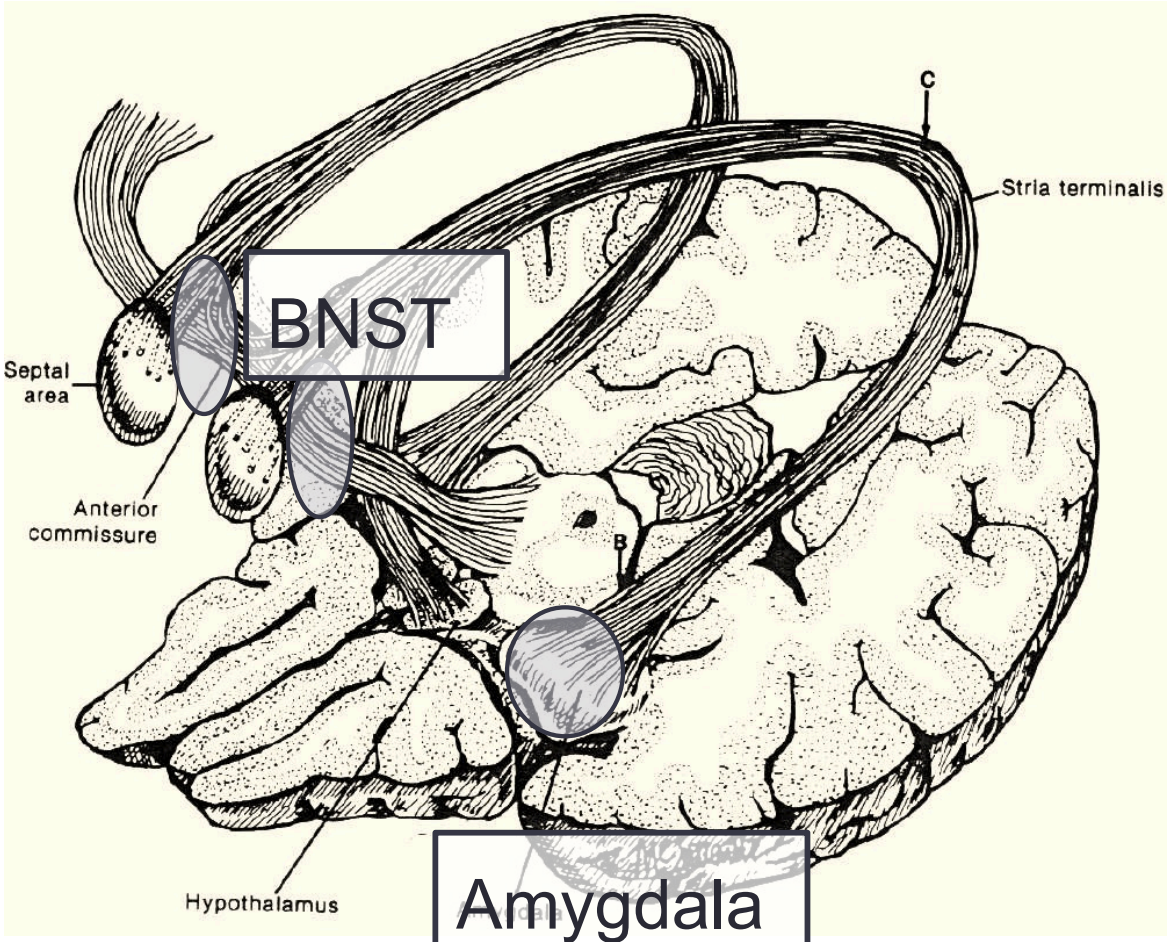
Homeostatic functions

- Food intake
  - Bilateral transections induce weight gain in female rats (King et al. 2003, Rollins 2006)
- Sexual activity
  - Lordosis in females (Takeo 1995)
  - Copulatory behavior in males (Lehman 1983, Tsutsui 1994))
- Neuroendocrine function
  - ST lesions completed inhibit adrenocortical responses to olfactory stimulation (Feldman and Conforti 1980)

Stria Terminalis: Clinical Pathologies

Translational Implications of the Amygdala–Stria Terminalis Model for the Clinical Anxiety Disorders

Ballenger 1989



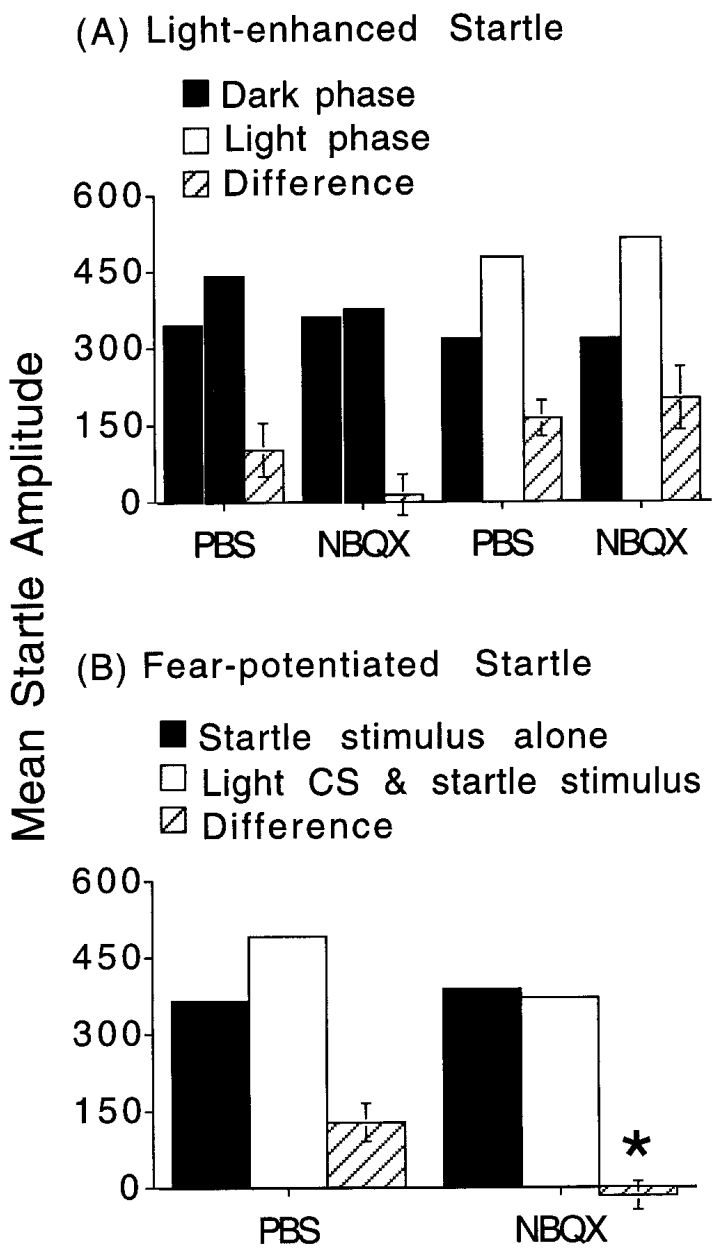
Double Dissociation Studies
Michael Davis

Light-enhanced startle – Acoustic startle response enhanced in the presence of bright light
Unconditioned Fear

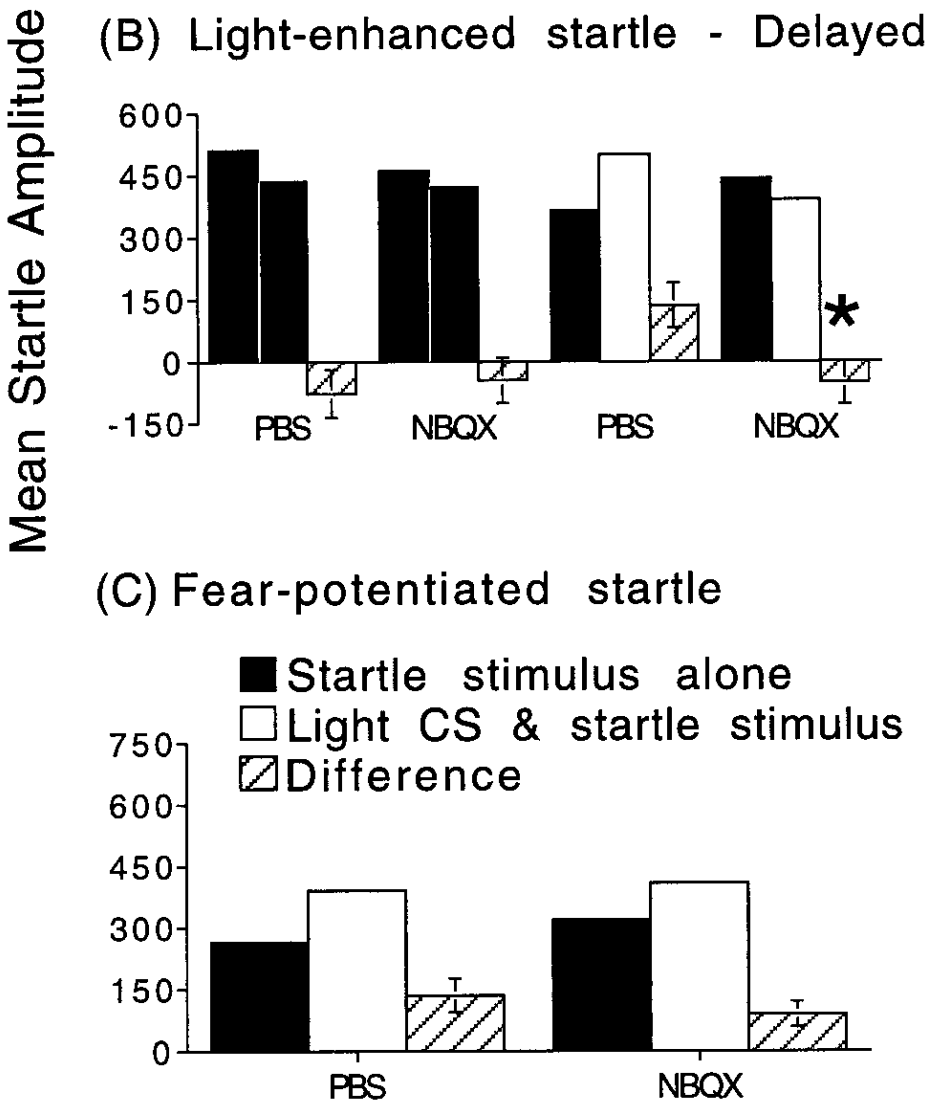
Fear-potentiated startle – Acoustic startle response enhanced in the presence of cues previously paired with shock – *Conditioned Fear*

Stria Terminalis: Clinical Pathologies

Central Amygdala Lesions



BNST Lesions



Walker and Davis 1997

Stria Terminalis: Clinical Pathologies

Because BNST lesions abolish Light-Enhanced Startle, which is unconditioned, it is thought to be more relevant to Generalized Anxiety Disorders, whereas Amygdala (central and basolateral nuclei) may be more relevant to disorders like PTSD.

Implicates Stria Terminalis in anxiety disorders