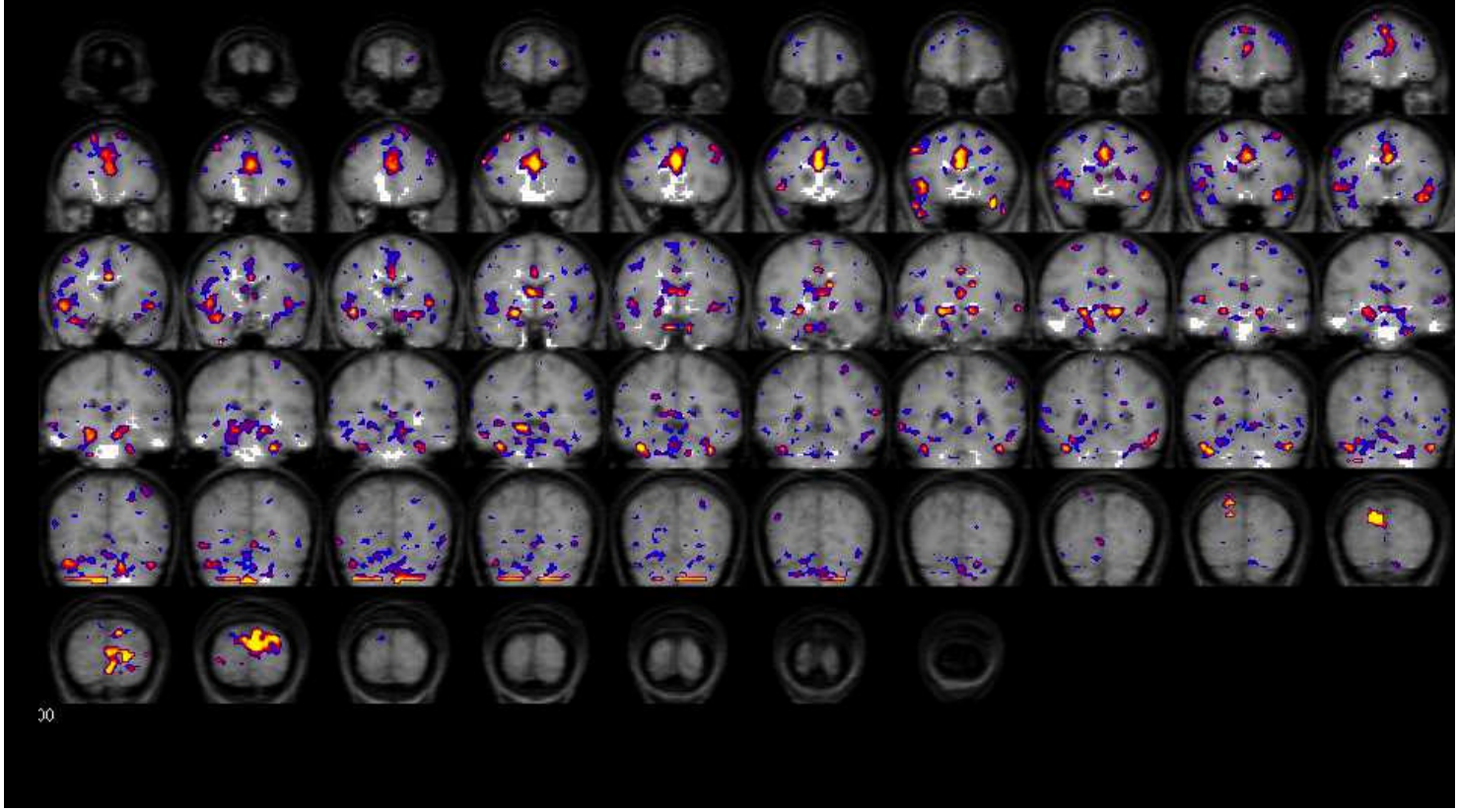
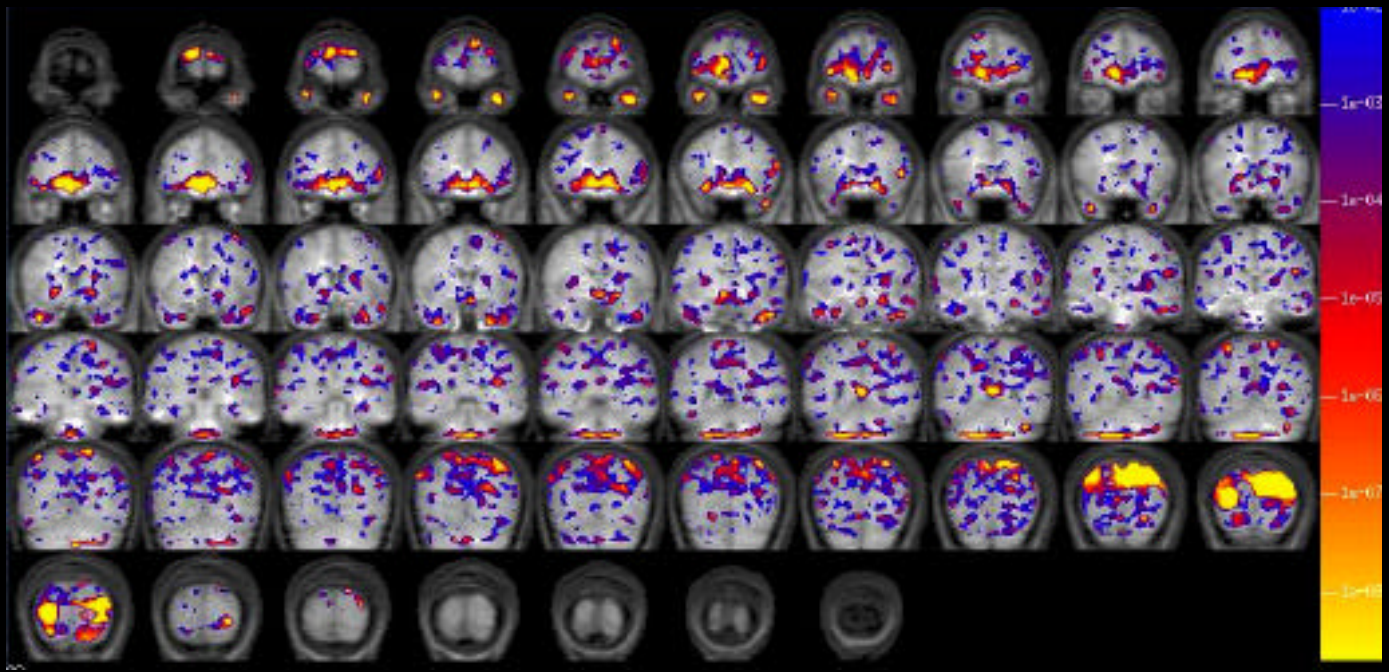
How do perception, cognition and behavior arise from an amorphous blob?

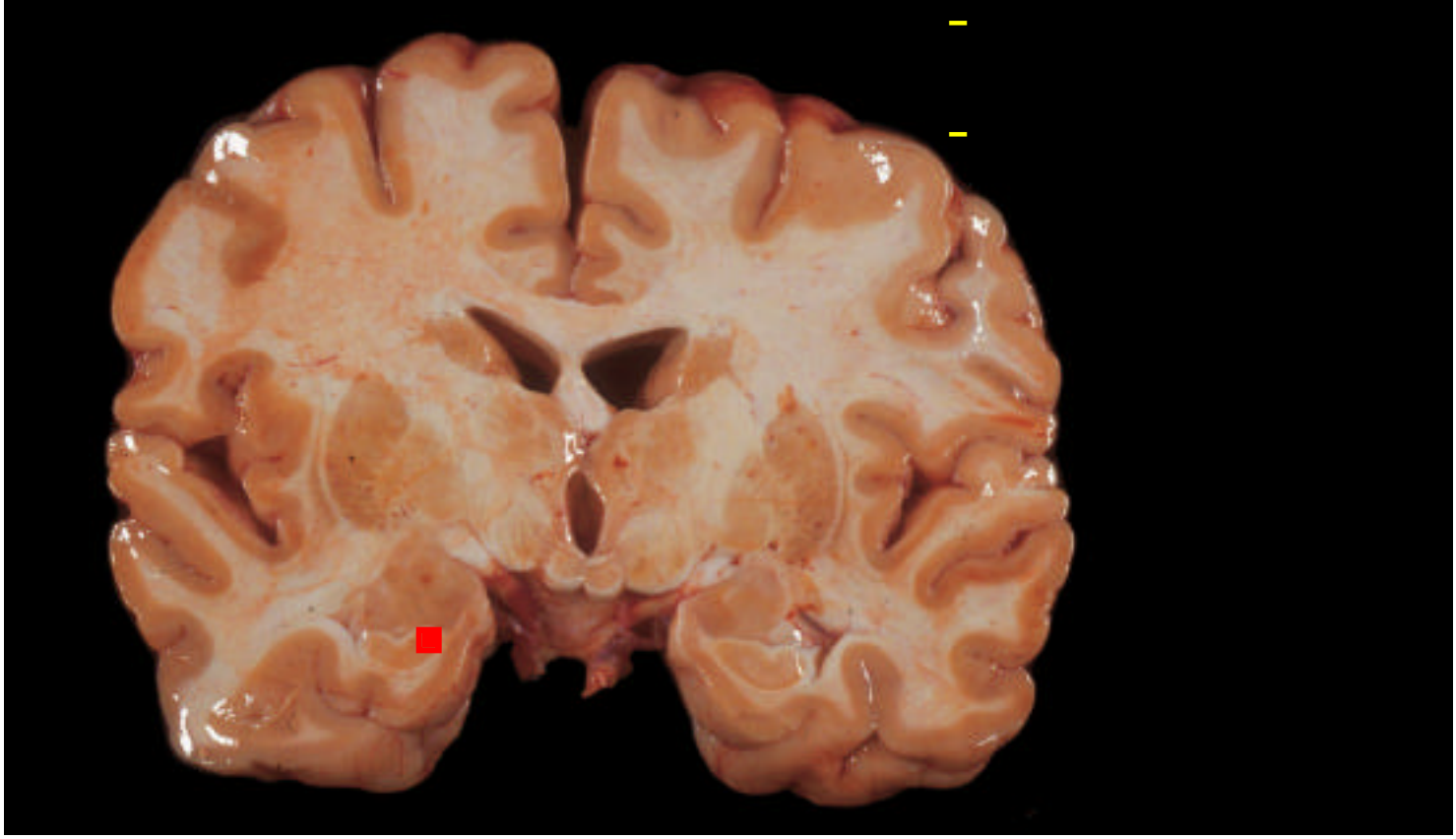
Cocaine induced fMRI signal increases…



And cocaine induced fMRI signal decreases

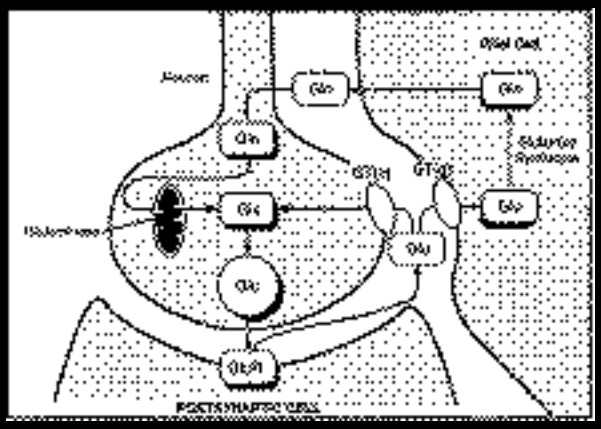


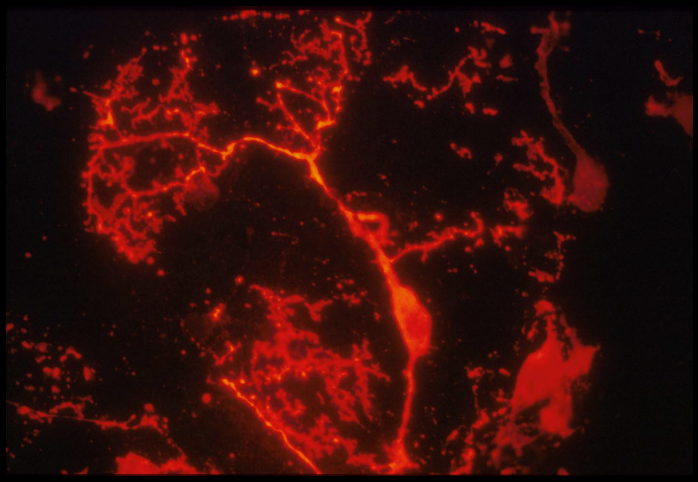
The Brain is Composed of Discrete Cells– Neurons, Glia and Vasculature



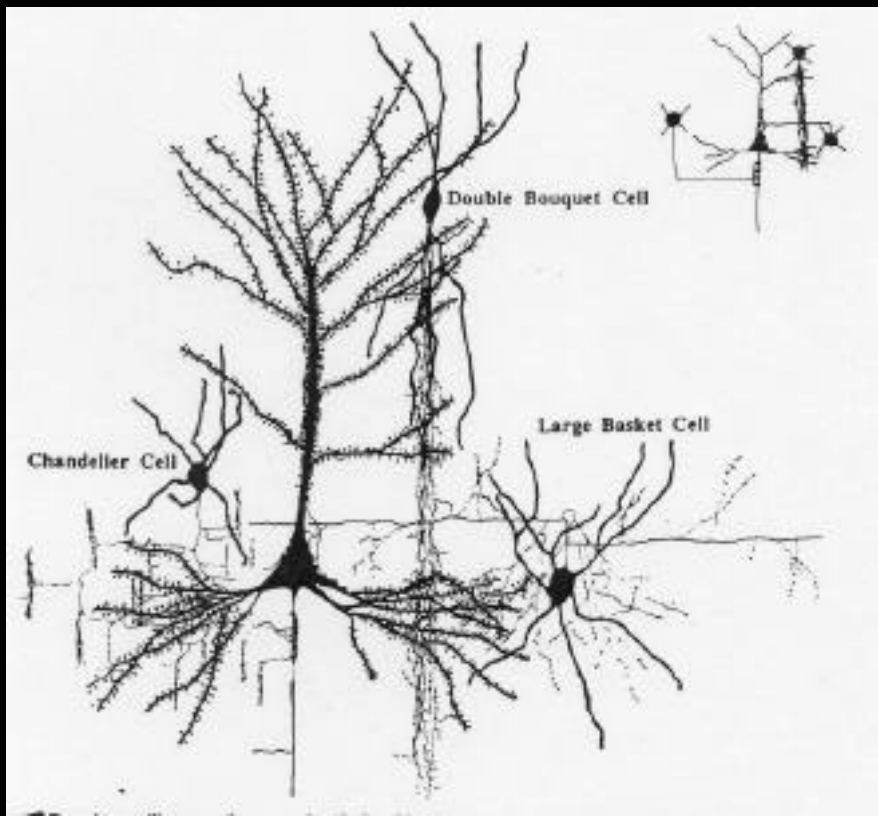
Glia support and maintain neurons

- Protect by surrounding and buffering
- Speed transmission by forming myelin sheaths





Neurons have specialized processes that support neurochemical transmission.

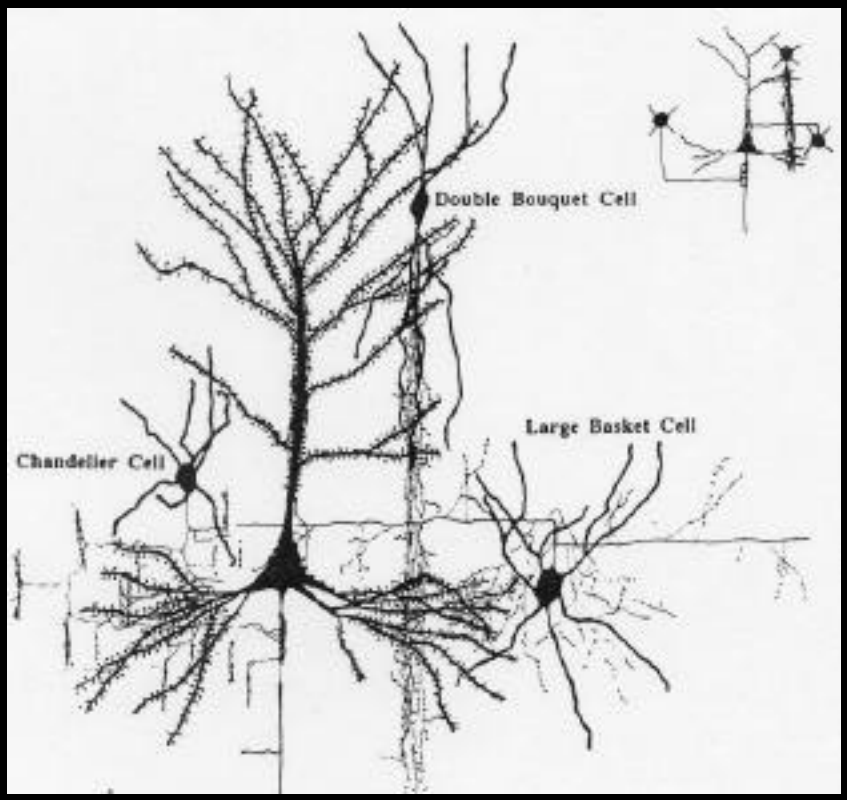


Neurotransmitter systems have unique properties

- **Excitatory Amino Acids– glutamate**
  - **Rapid point to point communication**
- **Inhibitory Amino Acids– GABA**
  - **Focus response**
- **Acetylcholine and Monoamines– NE, DA, 5–HT, EPI, histamine**
  - **Widespread modulation**
- **Neuropeptides– SubP, opioids, NPY & many more**
  - **Slower, longer lasting action**
- **More and More– NO, ...**

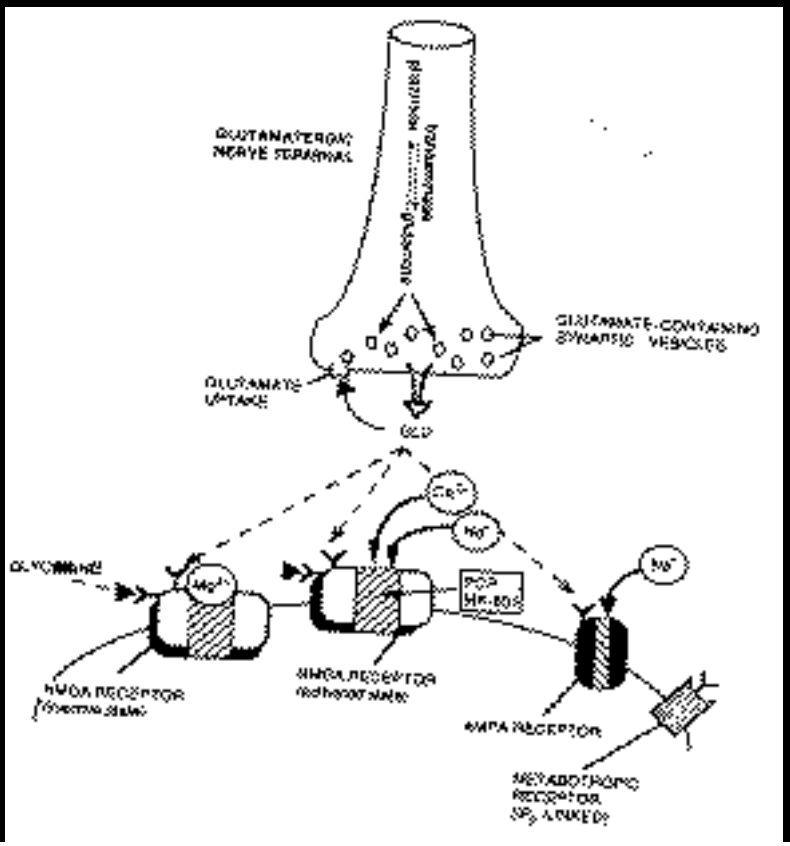
Inhibitory Amino Acids– GABA, glycine

- Primarily interneurons
- Projections include:
  - caudate, putamen, NAc, septum, SNr, cerebellar Purkinje
- Metabolically active
- Some co-express peptides (CCK, NPY)
- 5 Receptor subtypes– A, B1a, B1δ, B2, C

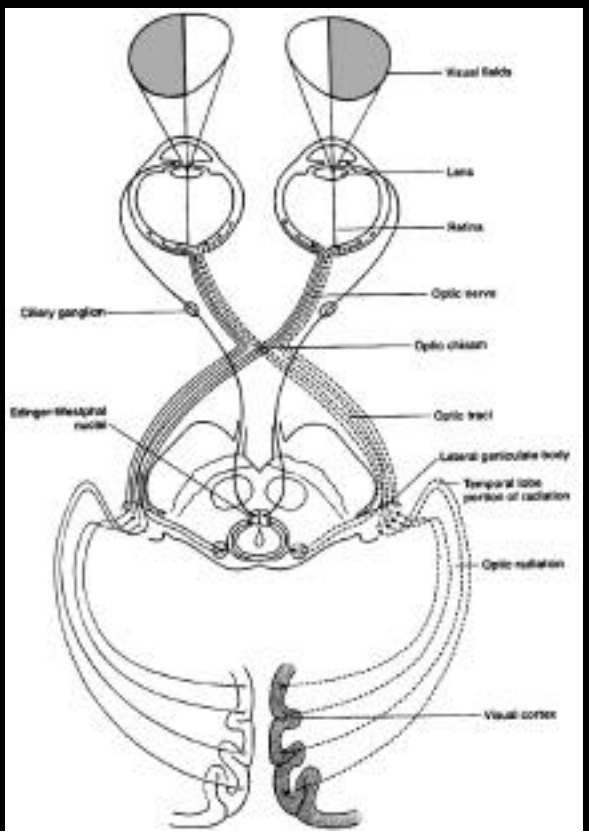


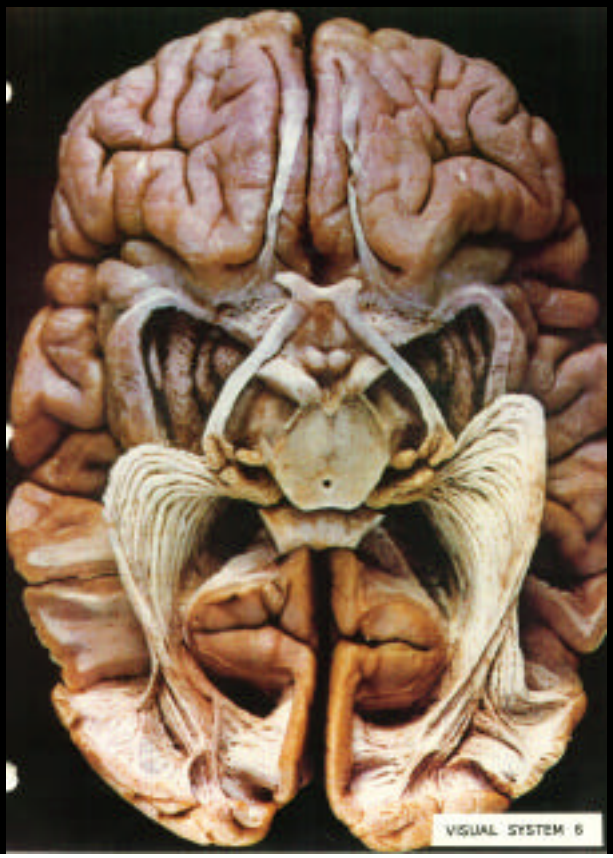
Excitatory Amino Acids–
Glutamate, Aspartate

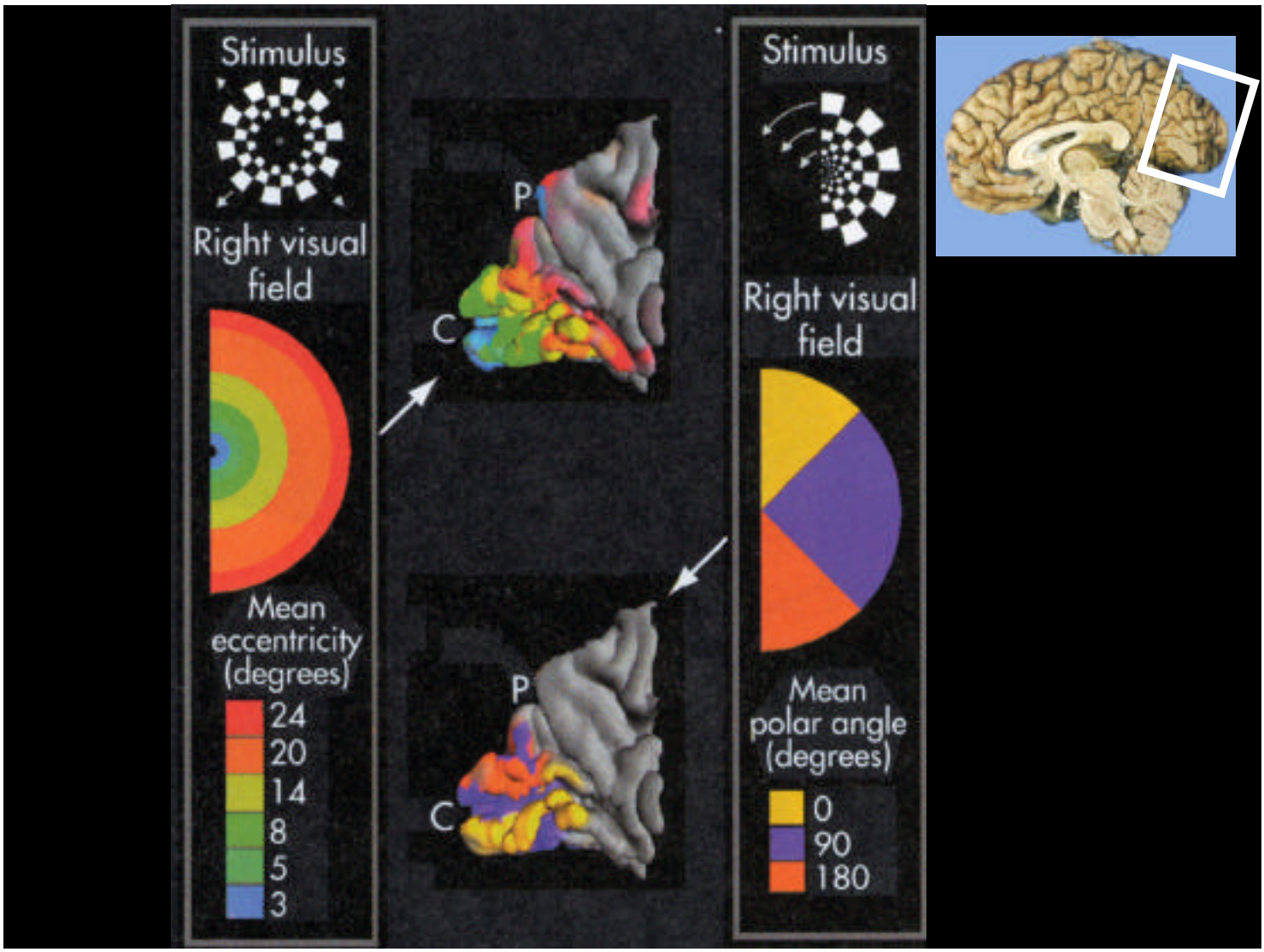
- Rapid point-to-point communication
- Most prevalent
- Place in cellular energetics
- Receptor subtypes–ligand gated channels & metabotropic
- Examples:
  - Cortical pyramidal cells
  - Thalamic relay neurons
  - Hippocampal granule and pyramidal neurons (CA1–3)
  - Cerebellar granule cells



Example of EAA mediated transmission: Visual perception

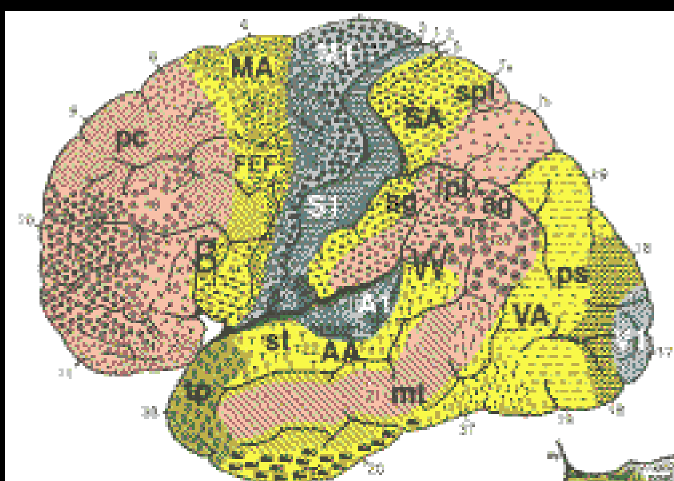
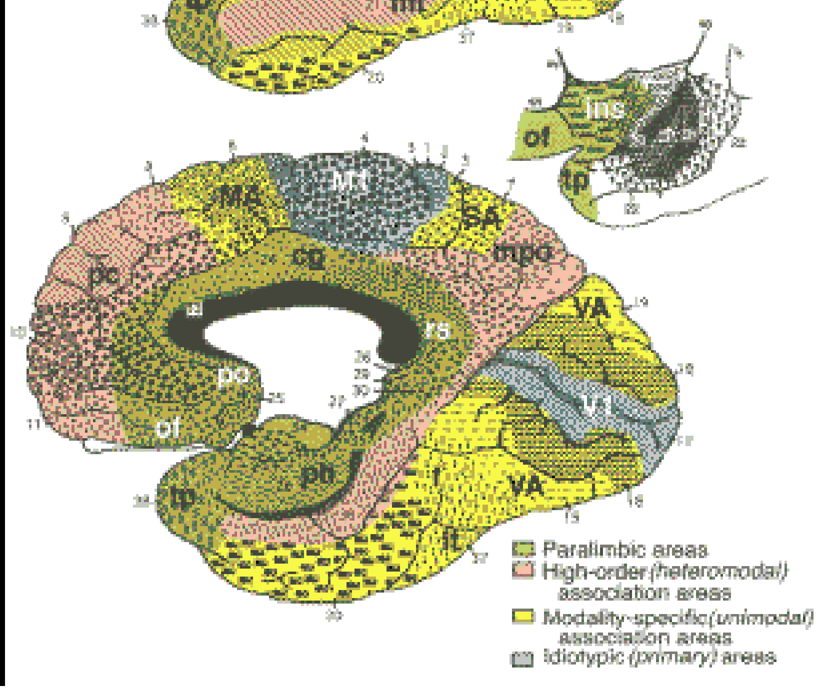


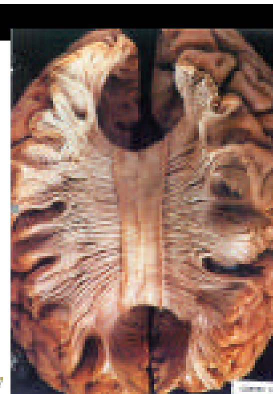


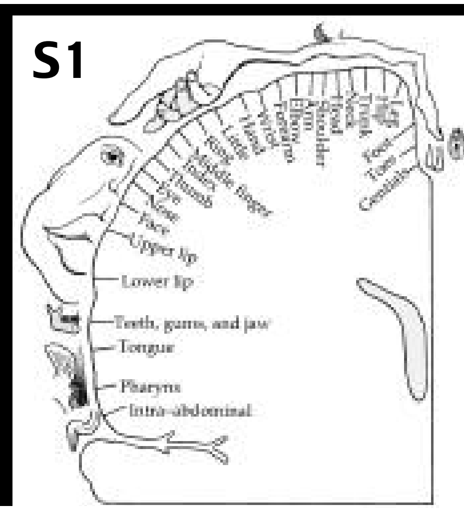

Stimulus
Right visual field
Mean eccentricity (degrees)
24
20
14
8
5
3
P
C
P
C
Stimulus
Right visual field
Mean polar angle (degrees)
0
90
180

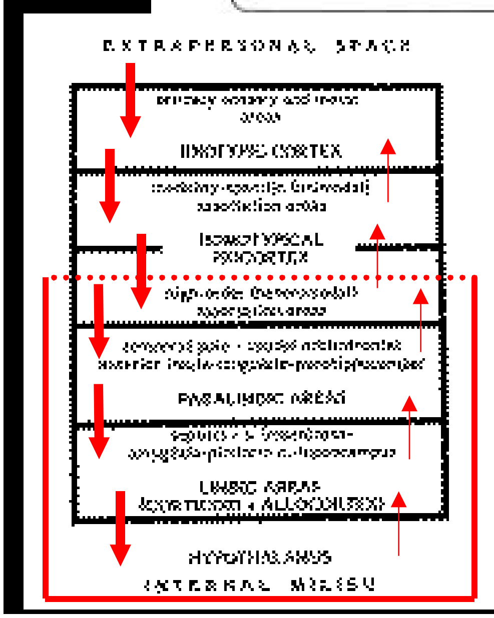
“Between sensation and action is cognition”

- Memory
- Emotion
- Attention
- Language
- Thought
- Consciousness



MA
M1
SA
spl
pc
FEF
S1
sg
ipl
ag
B
A1
AA
st
tp
mt
VA
ps
V1
ins
of
cg
mpo
rs
po
ph
ft
Paralimbic areas
High-order (heteromodal) association areas
Modality-specific (unimodal) association areas
Idiotypic (primary) areas



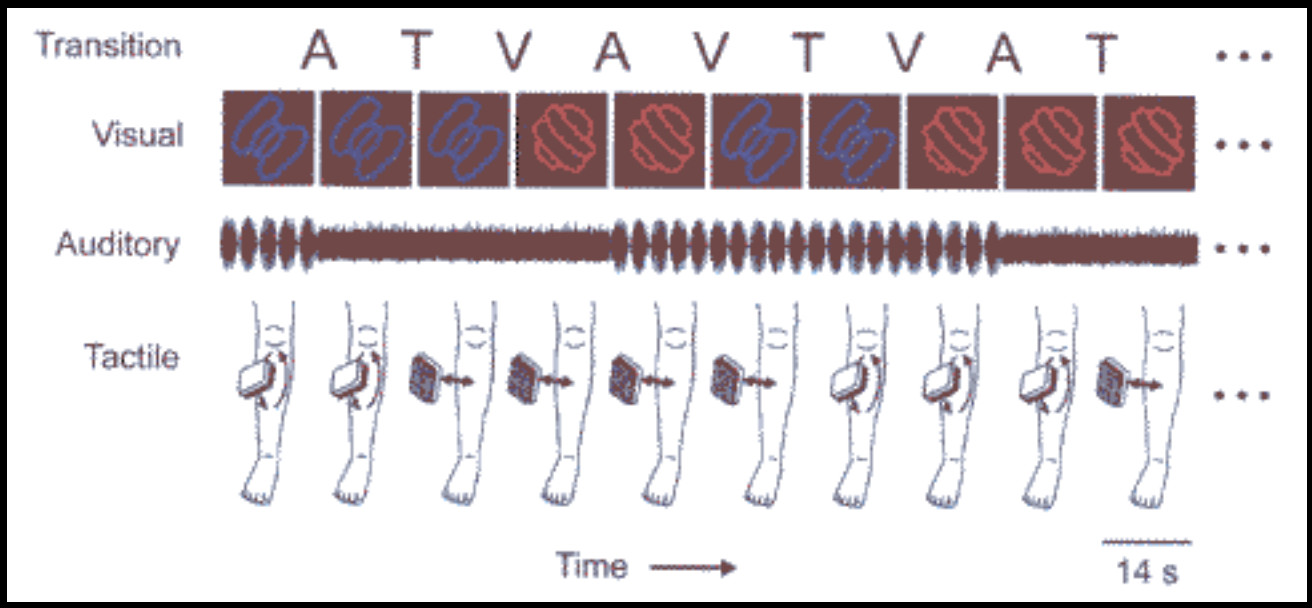

S1
Face
Upper lip
Lower lip
Teeth, gums, and jaw
Tongue
Pharynx
Intra-abdominal


EXTRAPERSONAL SPACE
IDIOTYPIC CORTEX
HOMOTYPICAL ISOCORTEX
PARALIMBIC AREAS
LIMBIC AREAS
HYPOTHALAMUS
INTERNAL MILIEU

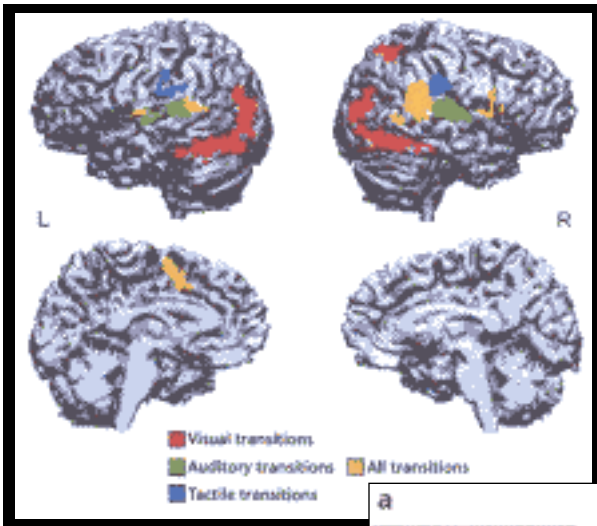
Epicenters of large scale networks

- Spatial awareness network
  - Posterior parietal and frontal eye fields
- Language network
  - Wernike's and Broca's areas
- Explicit memory/emotion network
  - Hippocampal-entorhinal complex and amygdala
- Face-object recognition network
  - Midtemporal and temporopolar corticies
- Working memory-executive function network
  - Lateral prefrontal and posterior parietal

Multimodal network for sensory detection

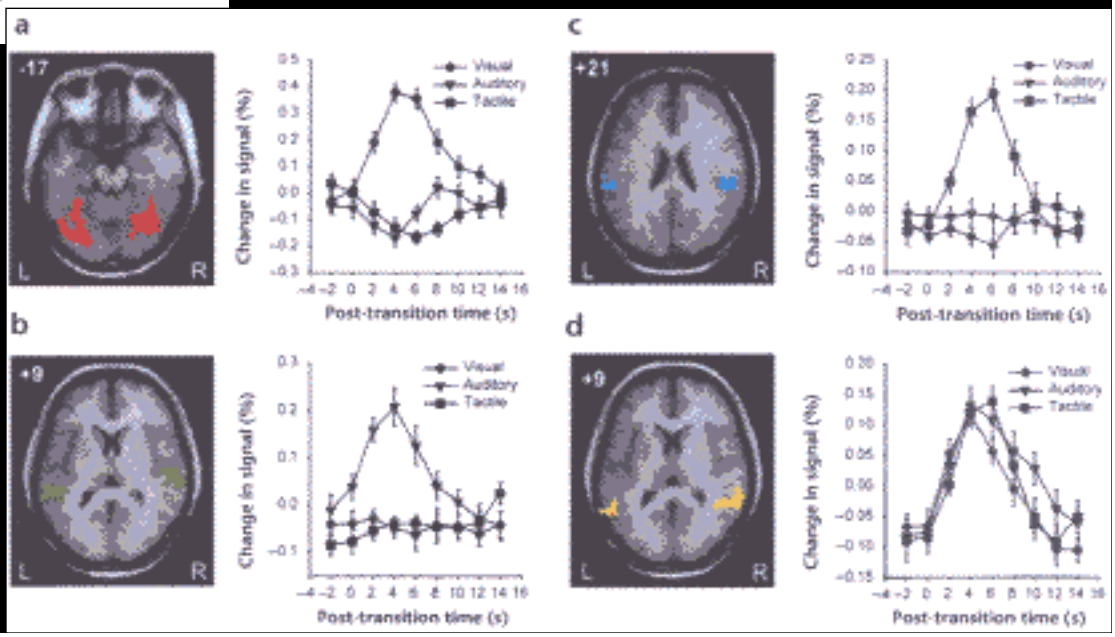


Excerpt of stimulus–presentation protocol



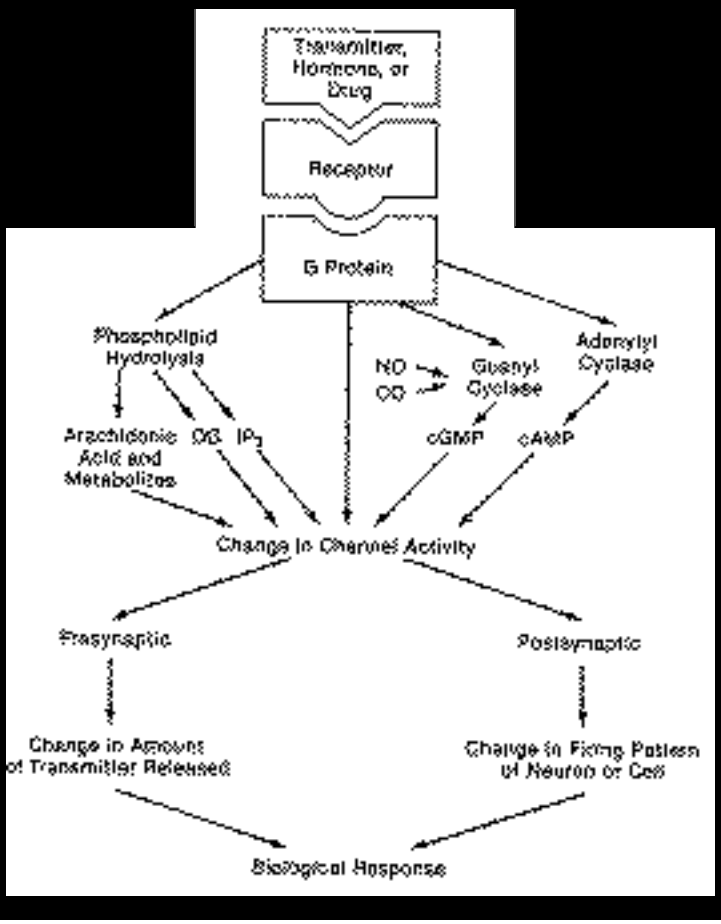
Surface rendering showing brain regions activated by transitions of unimodal and multimodal stimulus transitions

Averaged event-related hemodynamic responses to transitions



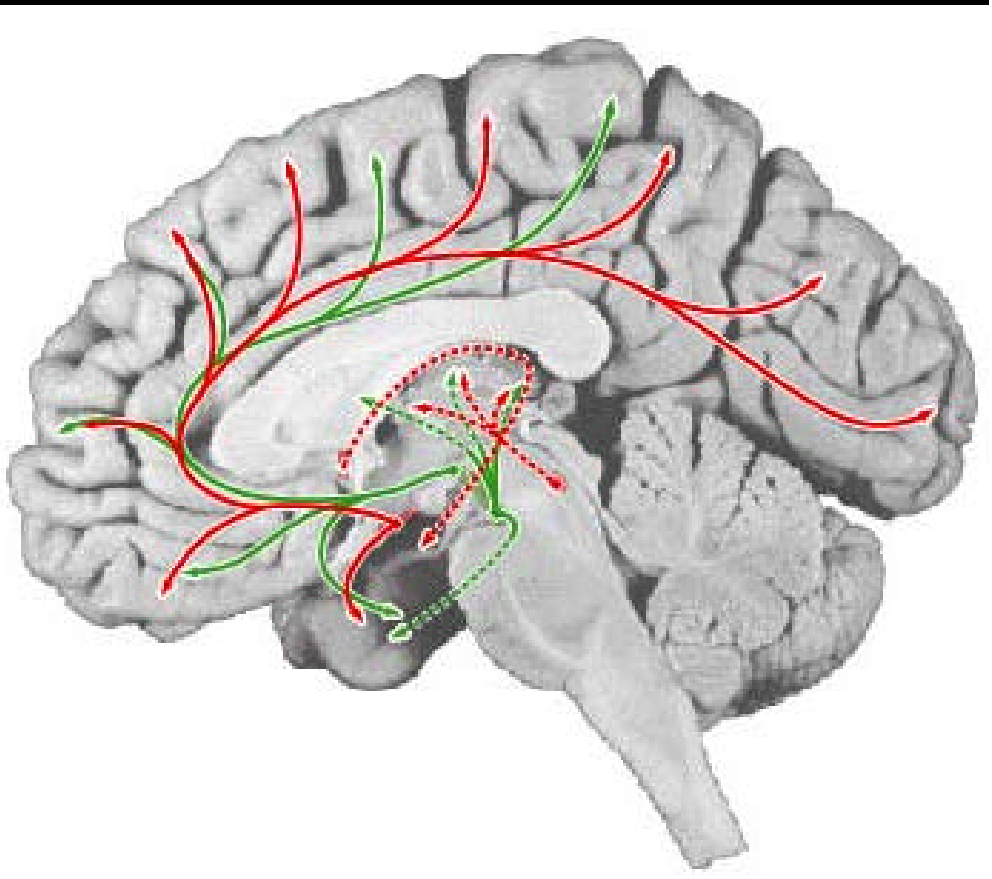
Modulation of Neuronal Activity

- Norepinephrine
- Dopamine
- Serotonin
- Histamine
- Acetylcholine

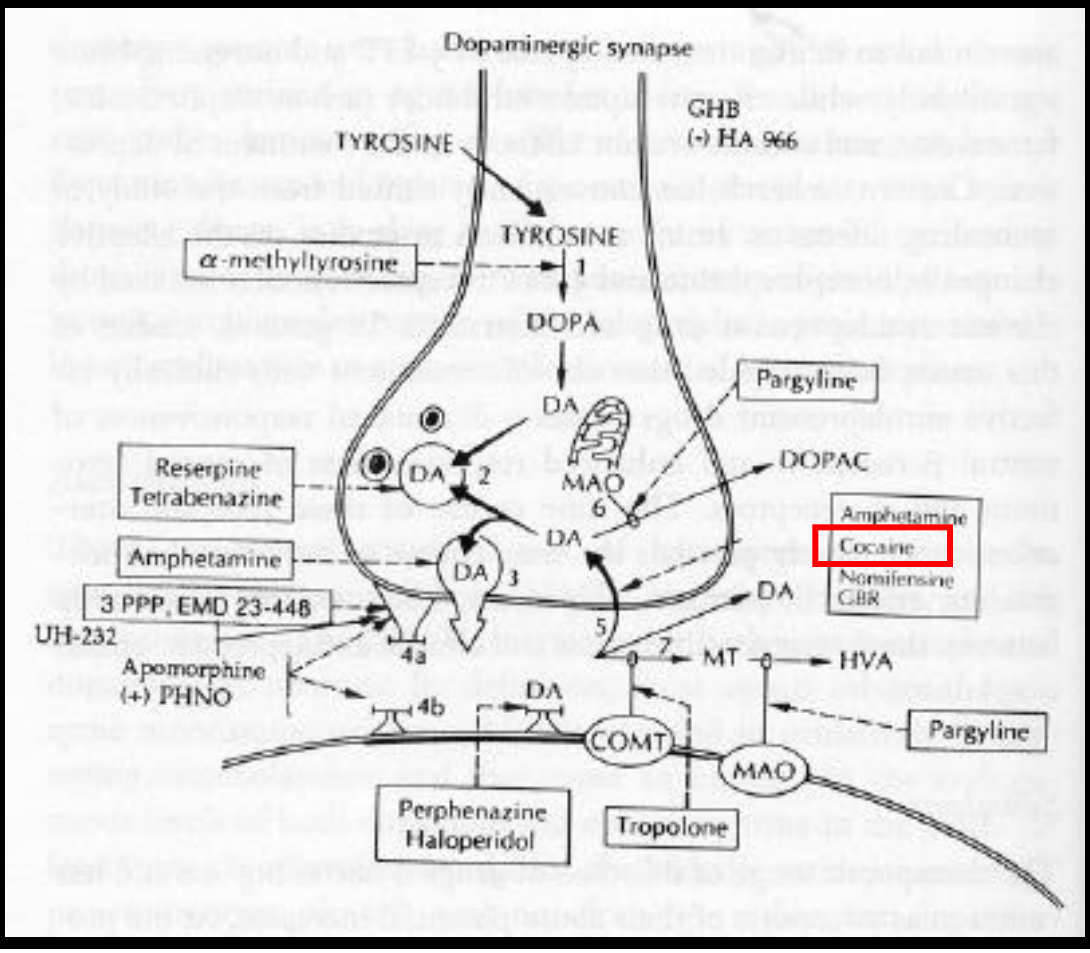


Ascending Dopaminergic Pathways

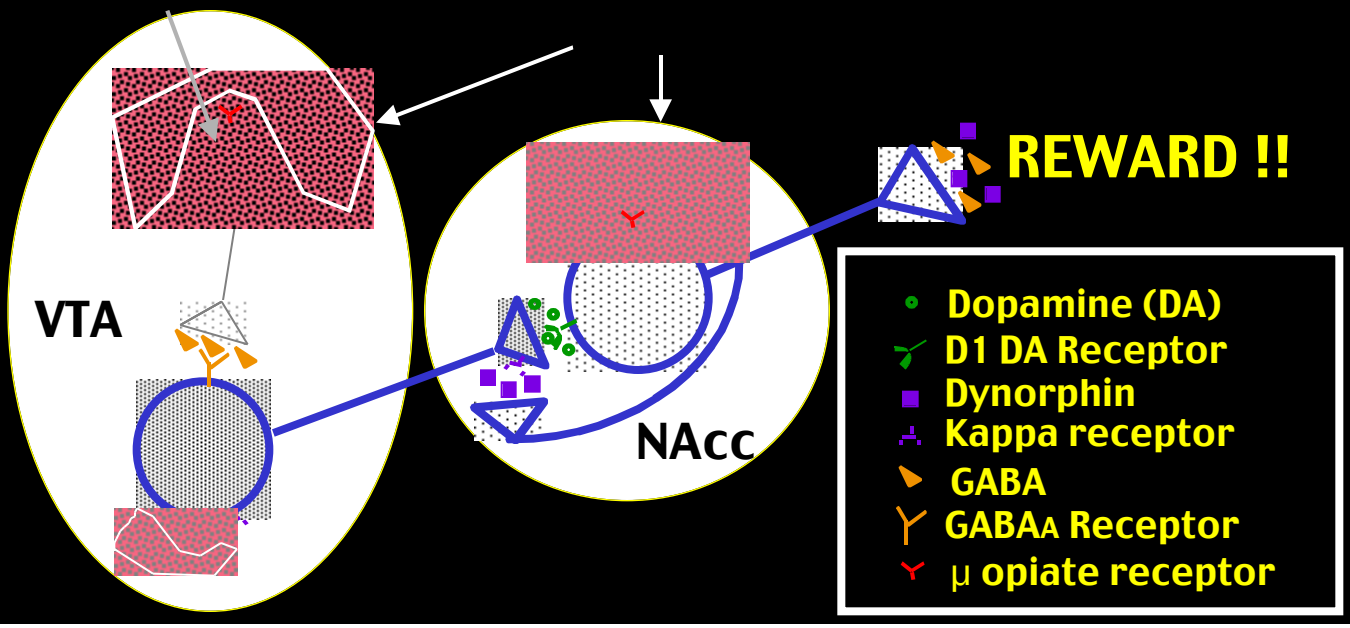
- Small clusters of neurons with widely ramifying axons
- Tonically active
- Firing rate regulated
- Synchronously acts on widespread target areas
- Receptor subtypes–G–protein mediated

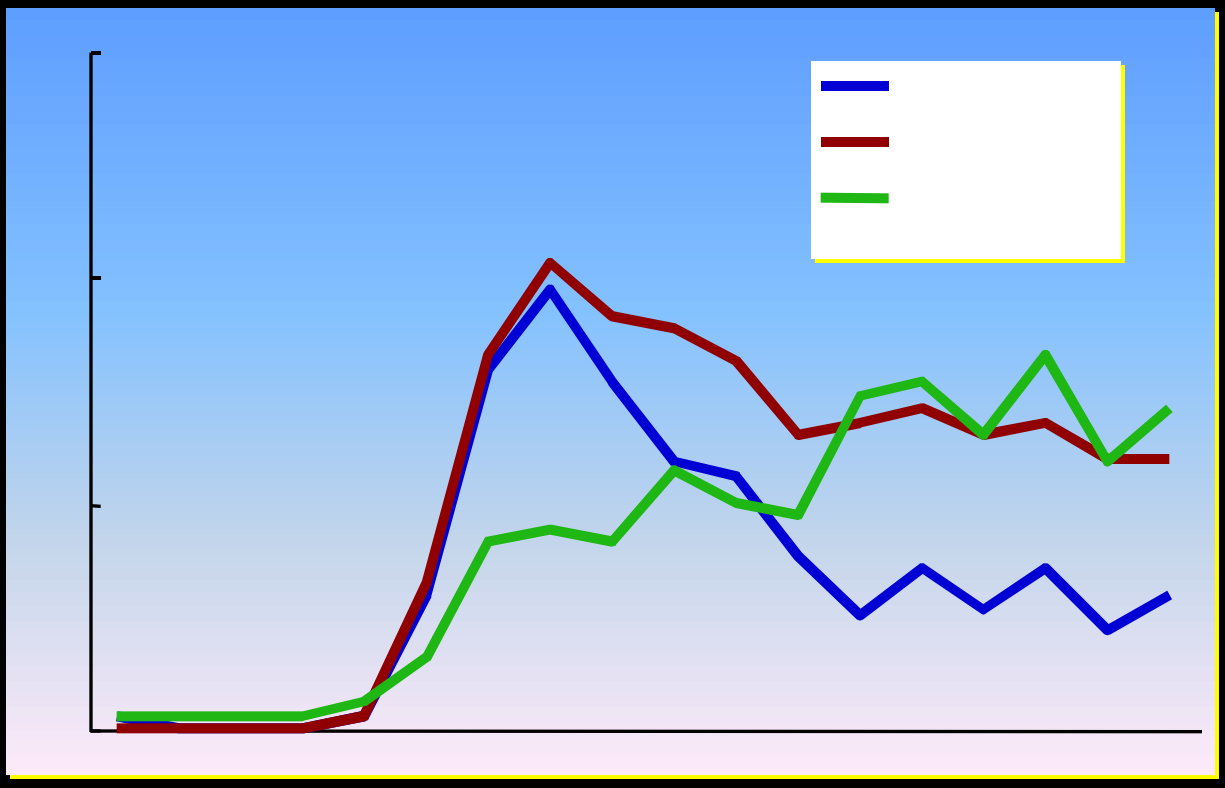


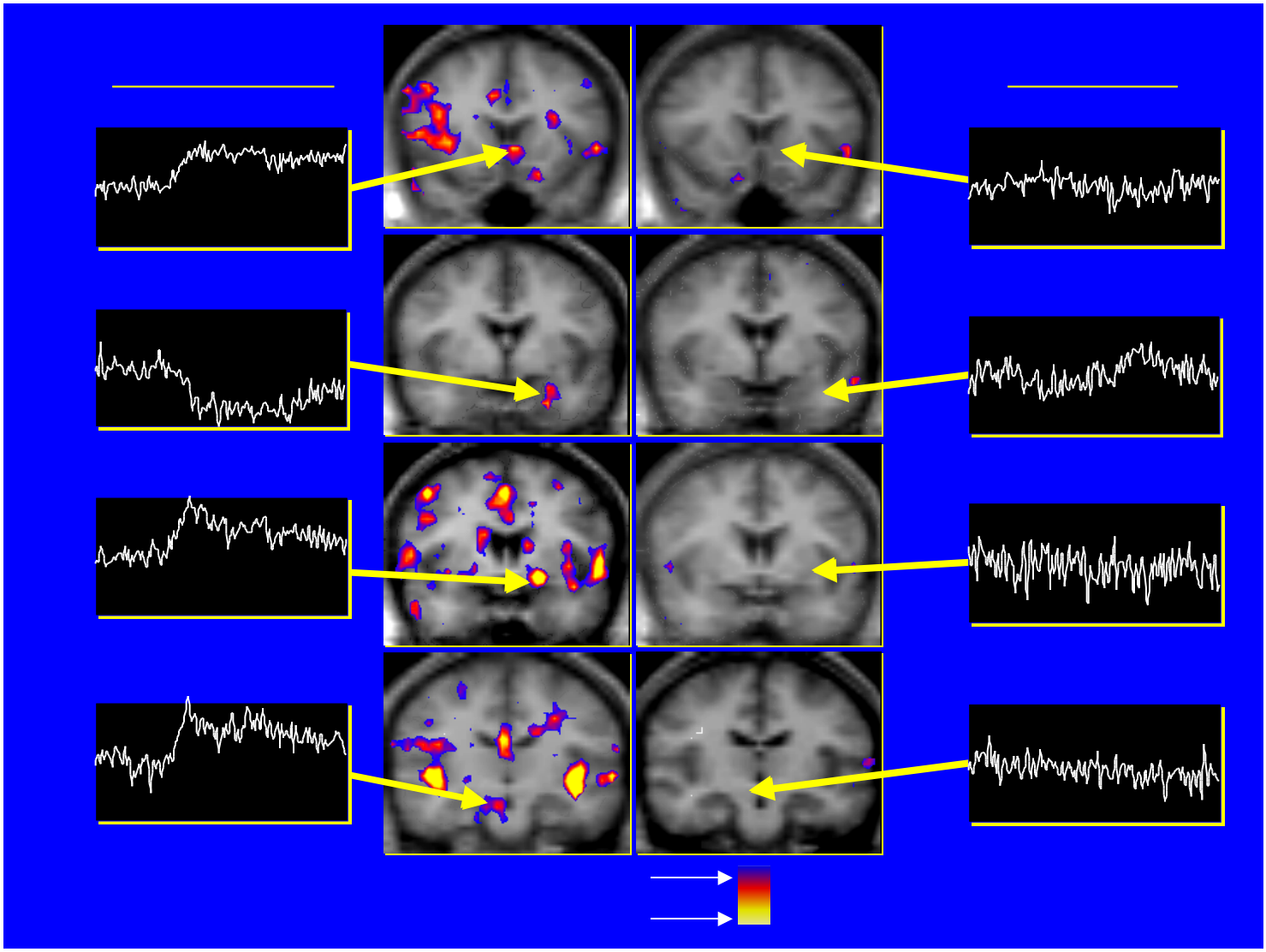
Dopaminergic neurotransmission



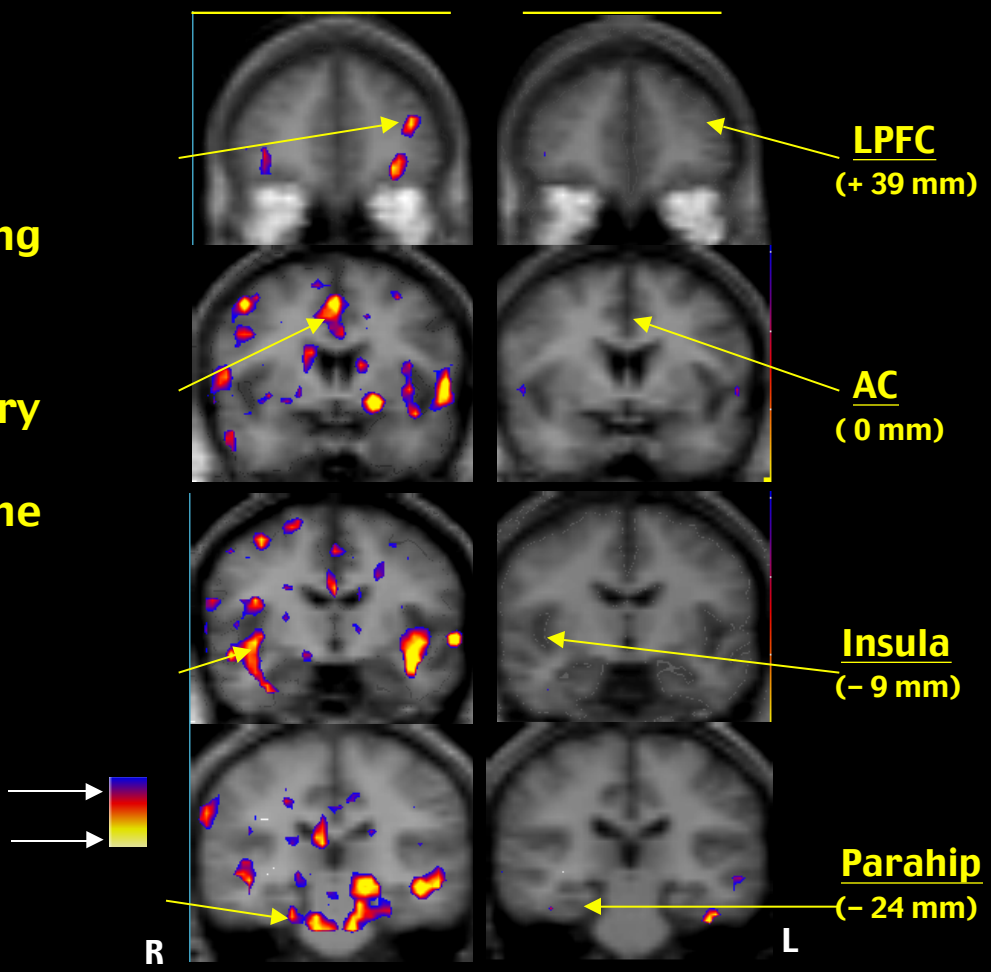
- Investigate the mediating neuroanatomy of acute cocaine reward and cocaine craving using fMRI.







- Concurrent rating task
- Cardiorespiratory activation and return to baseline



Knowledge of the underlying neurobiology is critical to successful fMRI experiments