Temporal Lobe Epilepsy

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Outline

- Epileptogenic zones
- Surgically remediable syndromes
- Presurgical evaluation
- Decision-making paradigm for temporal lobe epilepsy

Outline

- Anatomical considerations
- Anterior temporal lobectomy
- Selective Amygdalohippocampectomy
- Surgical risks
- Outcomes

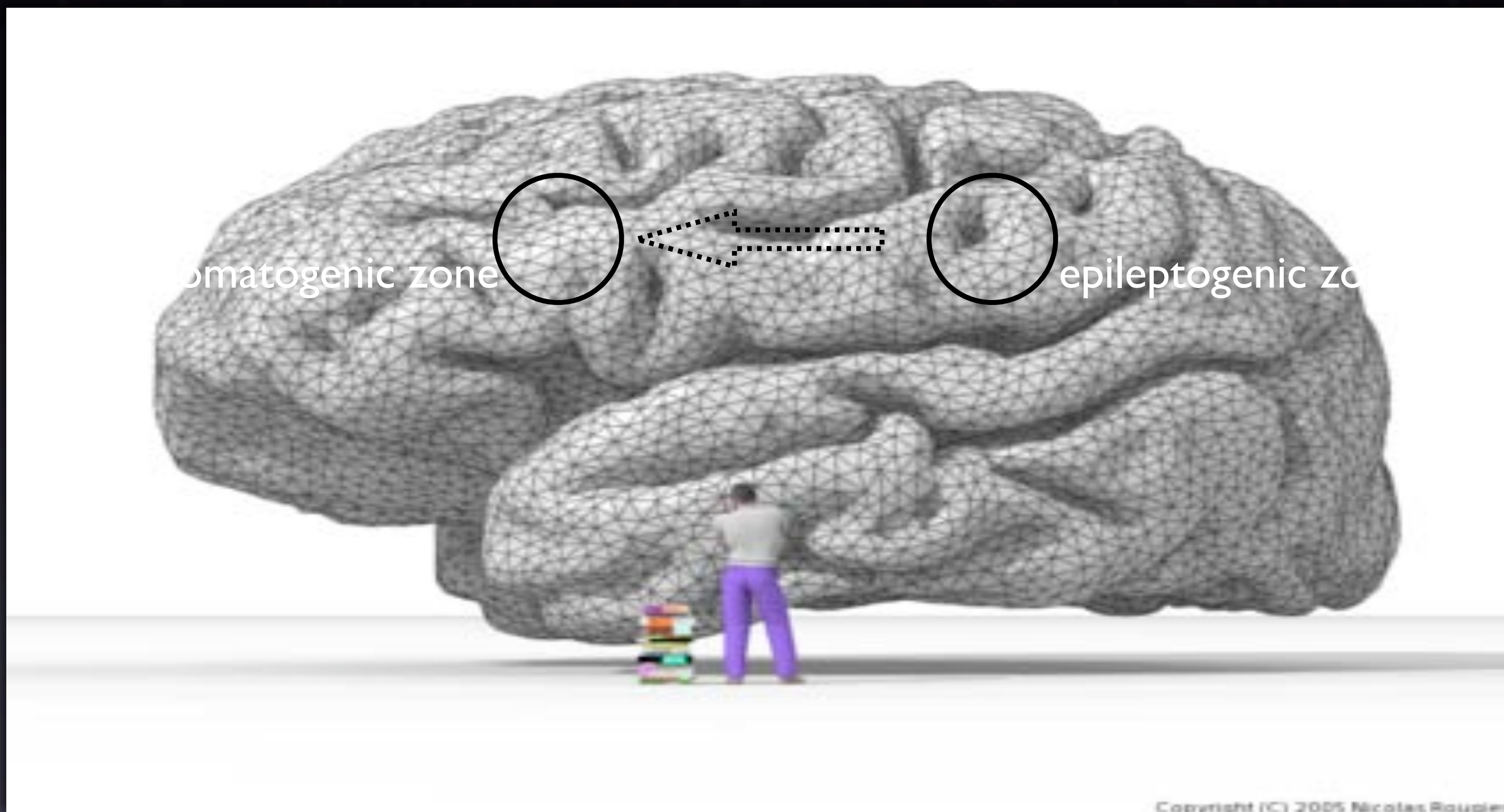
Epileptogenic Zone

- there are five different cortical zones that are used to define the epileptogenic zone:
  - symptomatogenic zone
  - irritative zone
  - seizure onset zone
  - epileptogenic lesion
  - functional deficit zone

Symptomatogenic zone

- this is the area of cortex that reproduces the *initial ictal symptoms* when activated by an epileptiform discharge
- may be localized vis a vis presenting history and video monitoring
- HOWEVER, the symptomatogenic zone may not overlap at all with epileptogenic zone...

Symptomatogenic zone



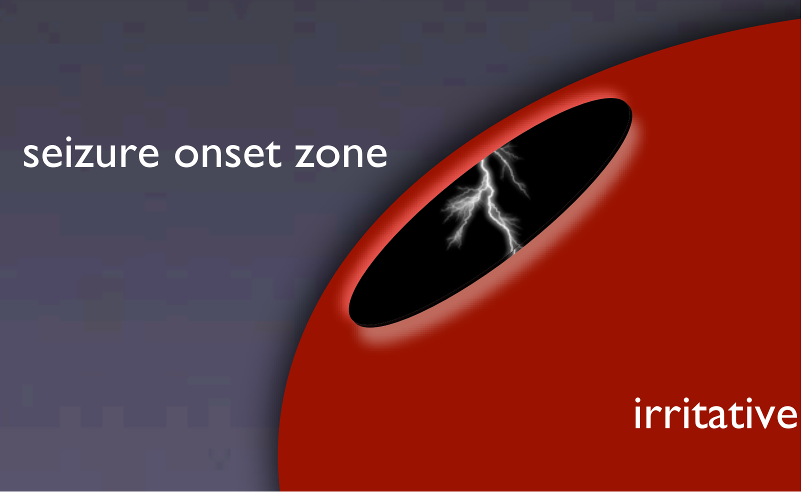
Irritative and Seizure onset zones

- the <u>irritative zone</u> is the area of cortex that generates <u>*interictal spikes*</u>...to produce symptoms, spikes must be strong enough to activate symptomatogenic zone

- <u>seizure onset zone</u> is the region of cortex from which seizures are generated

- again, the seizure onset zone may not be used to accurately define the epileptogenic zone

NB - EEG is a useful modality to defi
the irritative zone, but SPECT and fM
are also useful for the seizure onset zo



Epileptogenic Lesion

- defined as a radiographic lesion which is thought to be the cause of the seizures
- imaging must be correlated with EEG and video monitoring
- becomes especially problematic when there are multiple lesions

Functional deficit zone

- area of cortex that is functionally abnormal in the interictal period
- best defined with the neurological exam, neuropsychological testing, PET and SPECT scanning

Epileptogenic zone

- it is an amalgamation of 5 different zones
- each is best defined using different diagnostic modalities
- non-invasive evaluations cannot measure the epileptogenic zone; the only way to *directly* measure the epileptogenic zone is via invasive cortical mapping

Surgically Remediable Syndromes

Surgically Remediable Syndromes

- Temporal Lobe Epilepsy:
  - idiopathic
  - mesial temporal sclerosis
  - lesional (tumor, vascular malformations, ischemic, traumatic injury)
  - developmental

Surgically Remediable Syndromes

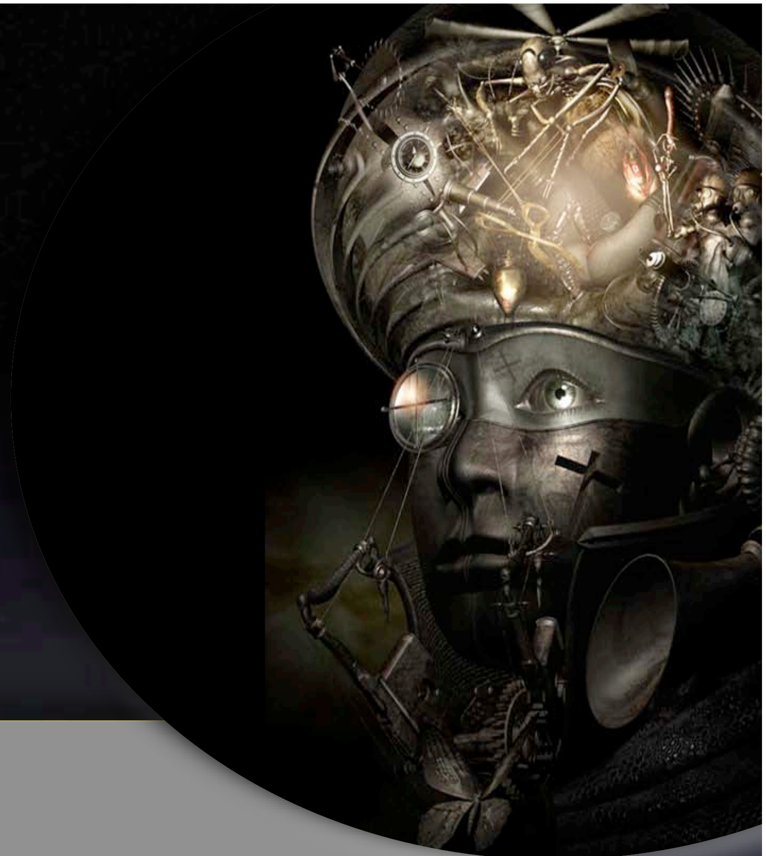
- Extratemporal epilepsy:
  - idiopathic
  - lesional (tumor, vascular malformation, ischemia, tumor)
  - developmental

Surgically Remediable Syndromes

- Catastrophic epilepsy:
  - lesional
    - hemimegalencephaly
    - diffuse cortical dysplasia
    - Sturge-Weber syndrome
    - Rasmussen's
    - Porencephalic Cysts

Surgical approaches

Type	Approach
Resective Surgery	Temporal lobe resection, extratemporal resectio lesional resection, anatomic/functional hemispherectomy
Radiosurgery	Mesial temporal lobe, hypothalamic hamartoma
Disconnection Surgery	Corpus callosotomy, keyhole hemispherotomie multiple subpial transections
Neuroaugmentative Surgery	Vagal nerve stimulator, hippocampal stimulation, d brain stimulation
Diagnostic surgery	depth electrodes, subdural strips or grids



Presurgical Evaluation

Phase 1: Noninvasive

Clinical Examination

Neuroimaging
(MRI, PET, SPECT, fMRI)

Electrophysiologic
(EEG +/- 24hr. video monitoring)

Neuropsychological testing

Psychosocial evaluation

Phase II: Invasive

Electrophysiologic

EEG +/- 24hr video monitoring

epidural electrodes

subdural electrodes

intracerebral electrodes

Neuropsychological Testing

intracarotid amobarbital testing

Electrophysiologic Monitoring

- invasive monitoring is used because, at times, the epileptogenic zone is not very well defined by scalp EEG due to artifact
- subdural electrodes:
  - placed on the surface of the brain as *strips* or a *grid*.
  - able to record from a large cortical surface without penetrating cerebral tissue
  - small risk of infection and hemorrhage ~4%

Electrophysiologic Monitoring

- depth electrodes:
    - require stereotactic placement
    - generally indicated for patients with *bitemporal, bifrontal or frontotemporal seizures*
    - risk of hemorrhage and infection ~1-4%
    - less frequently used with the advent of modern neuroimaging

Electrophysiologic Monitoring

- epidural electrodes:
  - placed through tiny openings in the skull such that electrodes lie in contact with dura
  - low risk of infection because dura is *not* penetrated
  - recordings susceptible to *artifact* relative to subdural recordings.

Neuropsychological testing

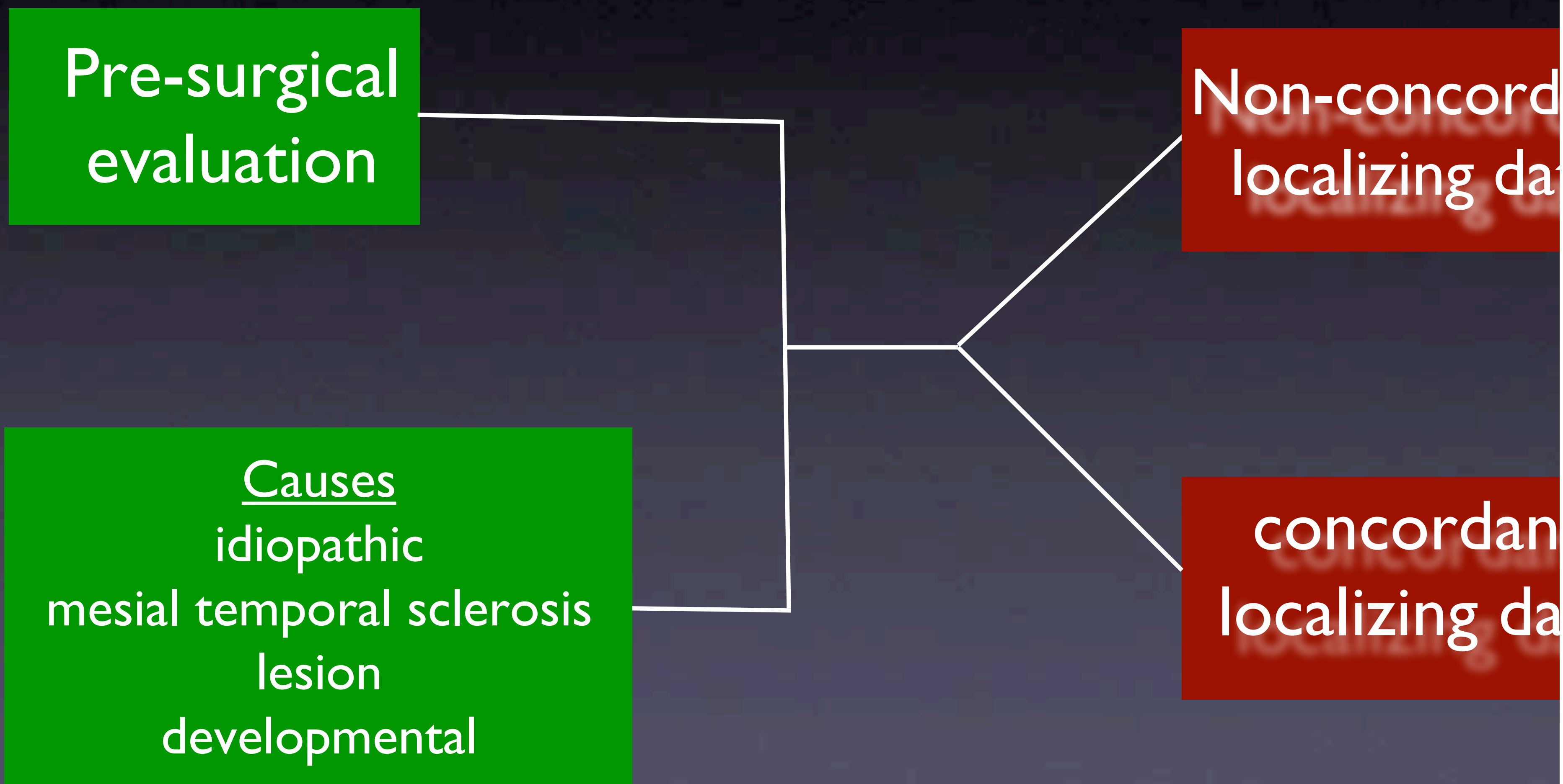
- generally interested in assessing *memory function* (verbal vs non-verbal memory, amnesia), *language*, and *cognitive function*
- many different scales used for assessment - institution dependent
- the intracarotid amytal procedure (aka Wada test) used to assess *lateralization of language* and also adapted to identify patients at risk for *memory loss*

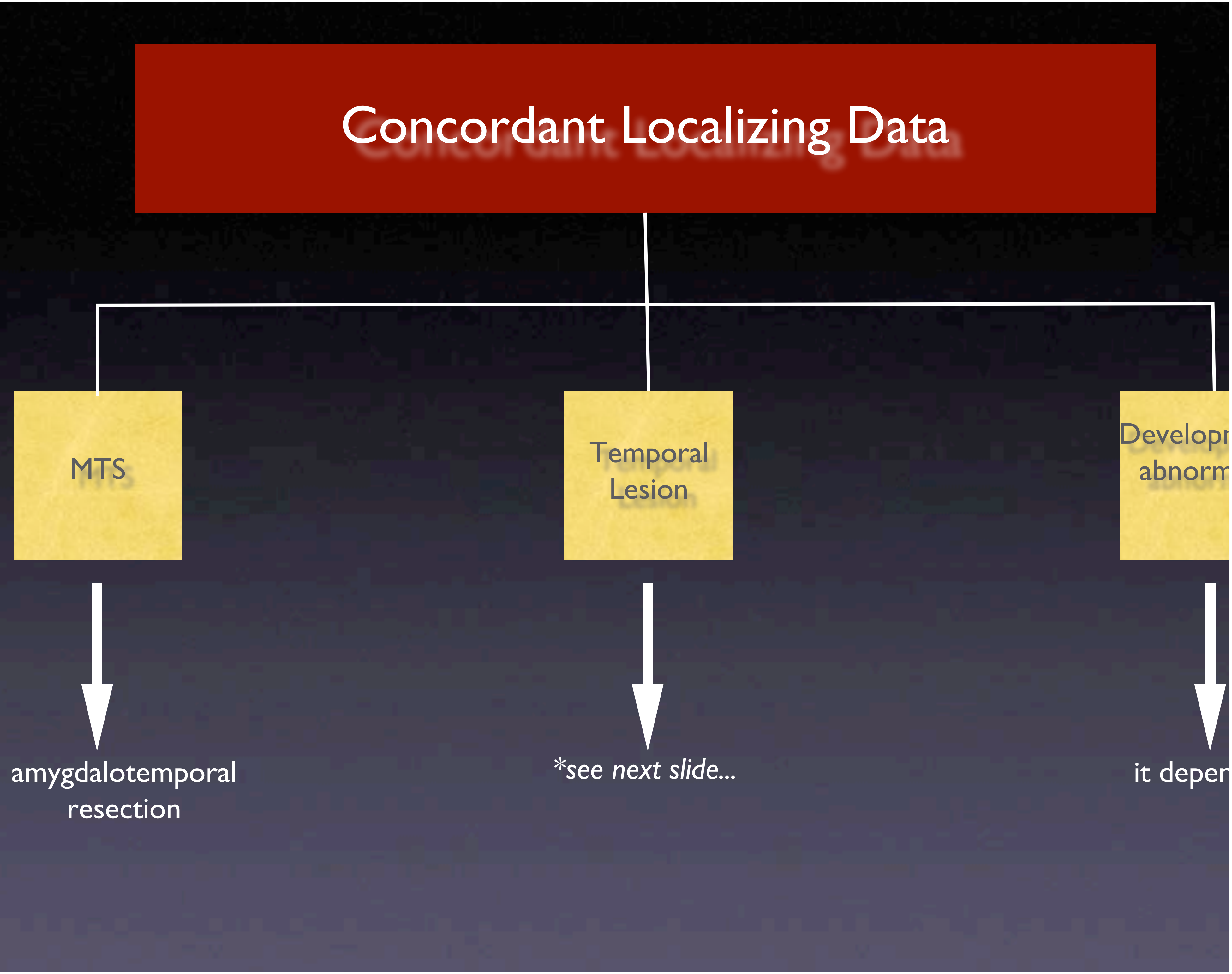
Intracarotid Amytal Test

- Two major assumptions about how this works:
  - hemisphere perfused with amobarbital is non-function
  - provides an estimate of pos operative changes if surgery done on the side of perfusi

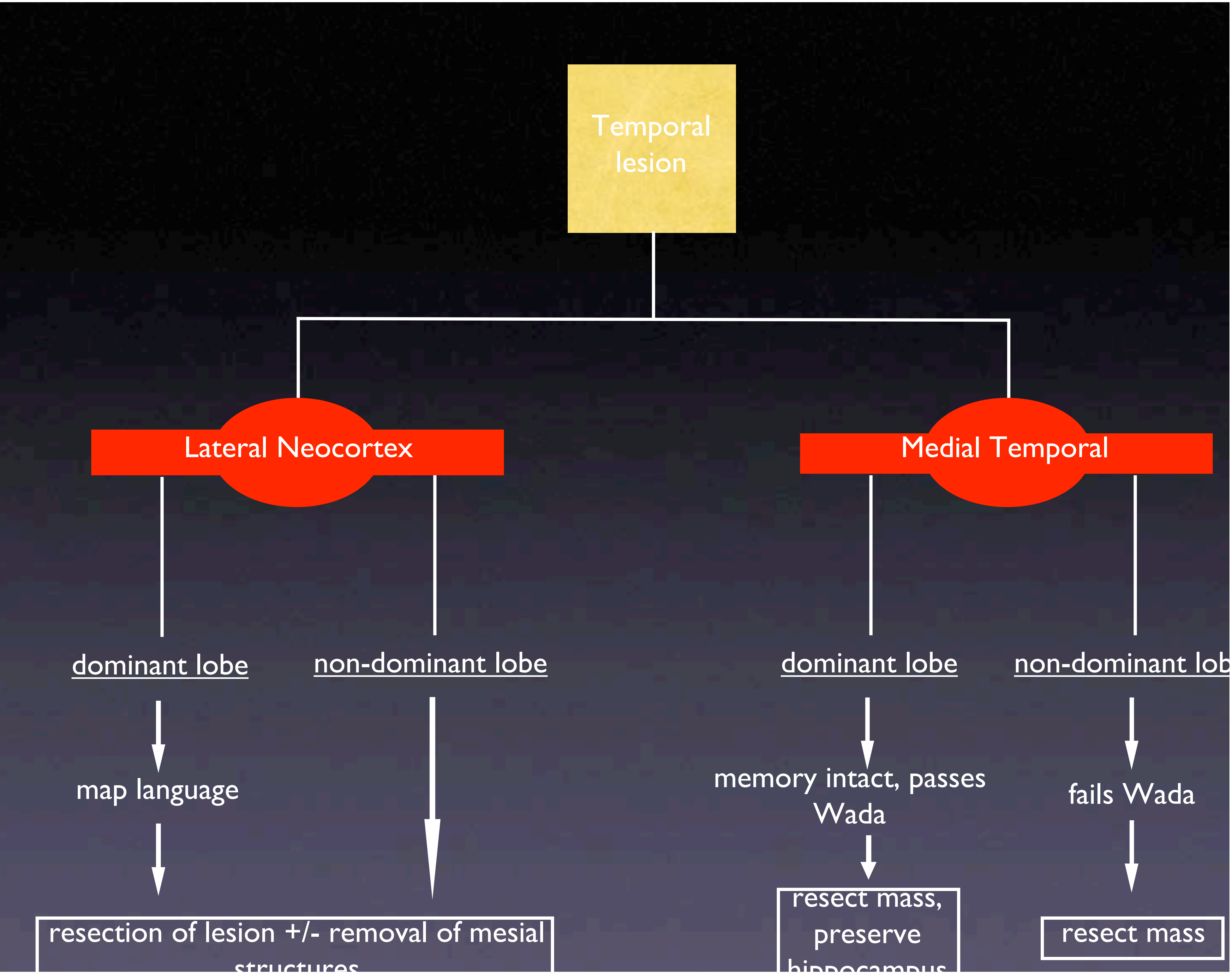
Decision-making paradigm

Decision-making Paradigm

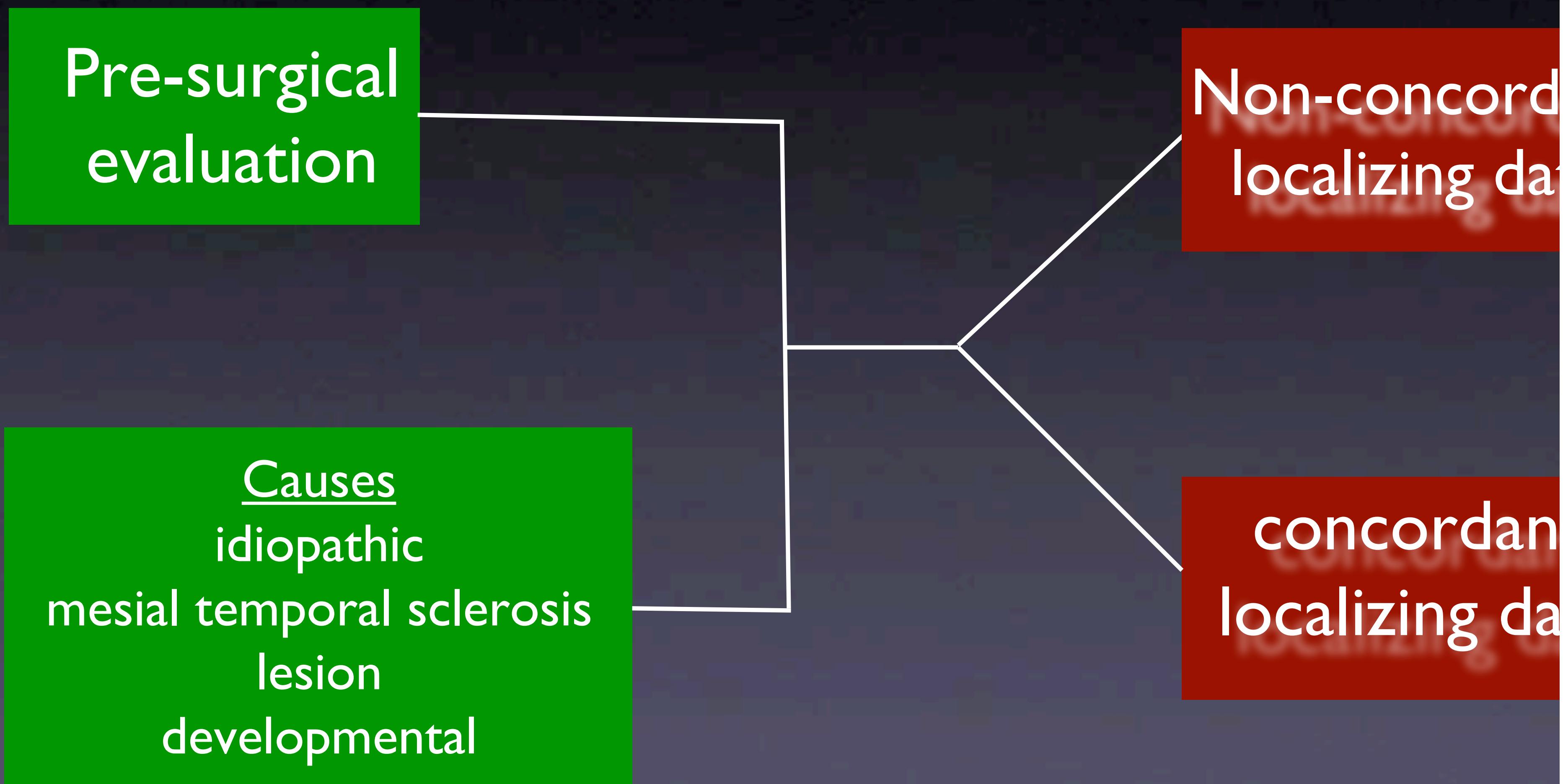


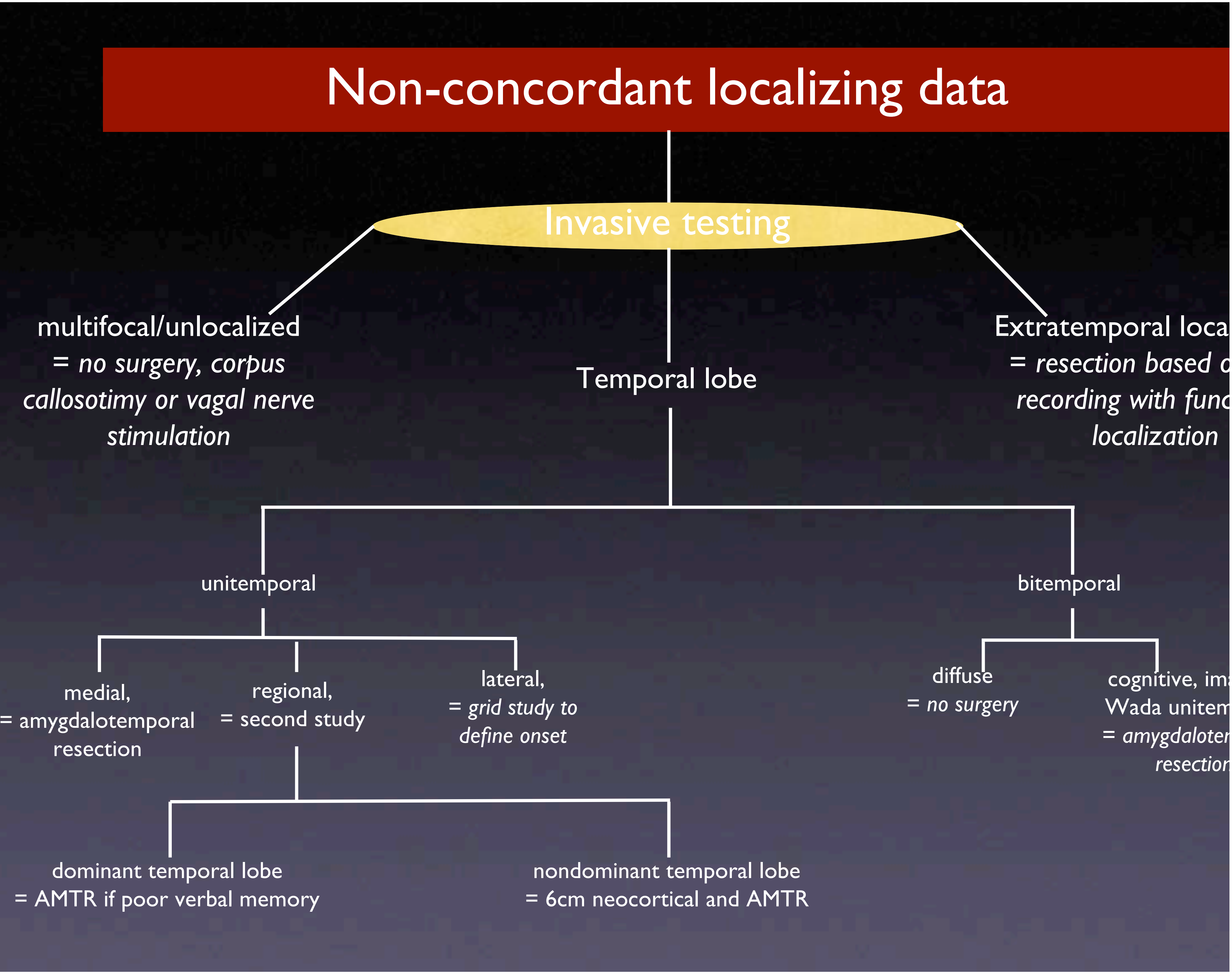


Concordant Localizing Data
MTS
Temporal Lesion
Develop
abnorm
amygdalotemporal resection
*see next slide...
it depen


Temporal lesion
Lateral Neocortex
Medial Temporal
dominant lobe
non-dominant lobe
dominant lobe
non-dominant lob
map language
memory intact, passes Wada
fails Wada
resection of lesion +/- removal of mesial structures
resect mass, preserve hippocampus
resect mass

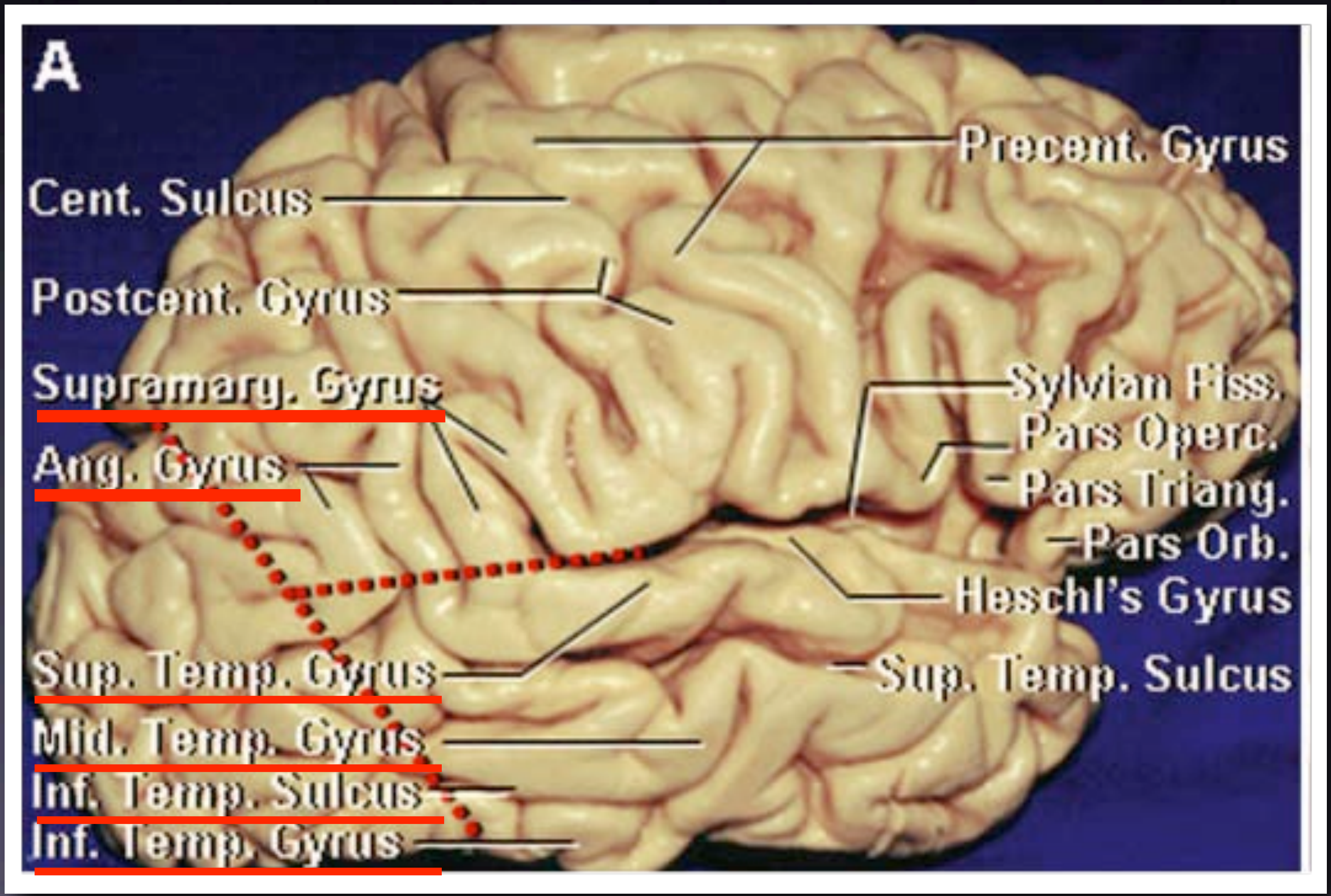
Decision-making Paradigm



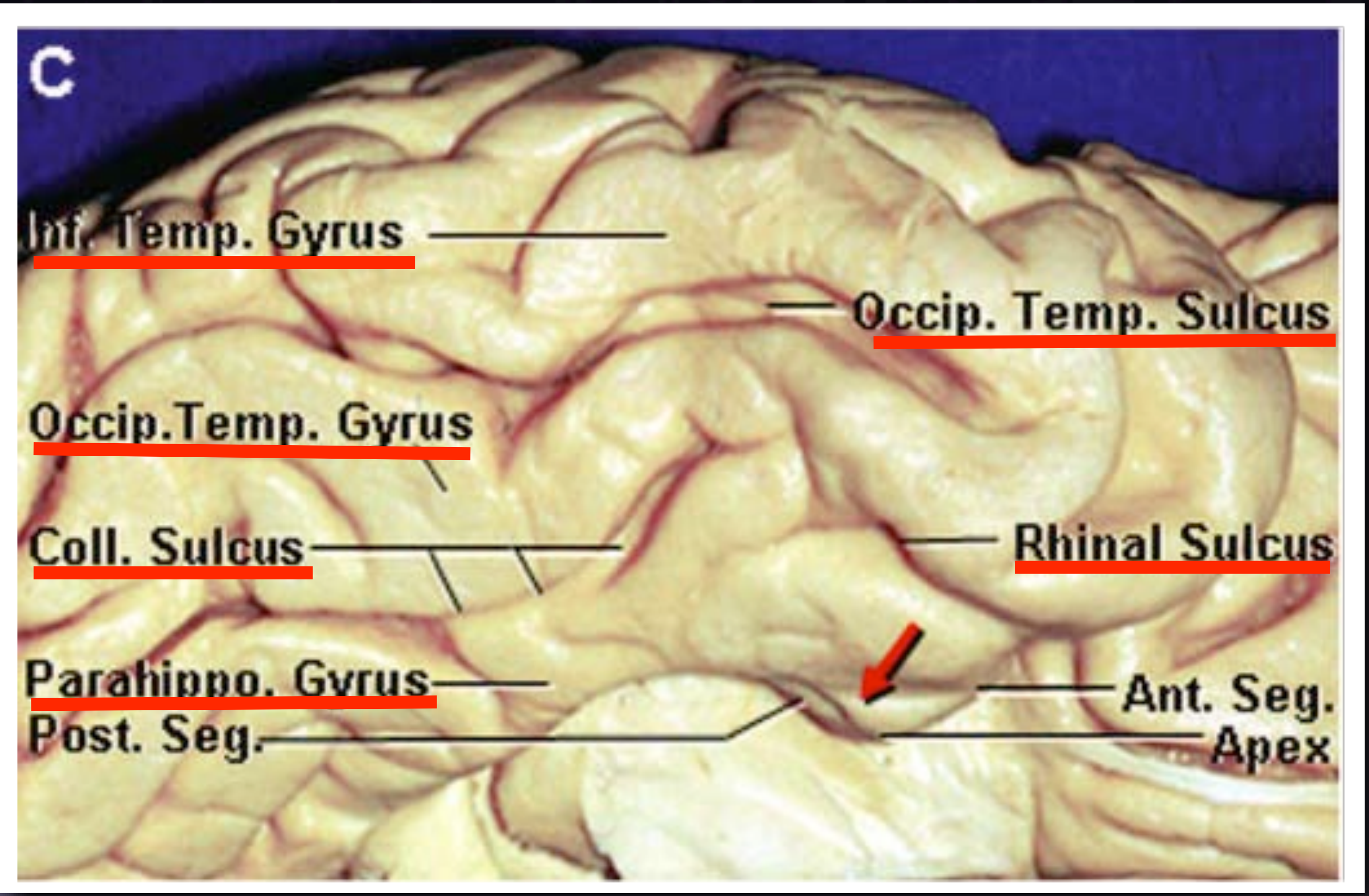

Non-concordant localizing data
Invasive testing
multifocal/unlocalized
= no surgery, corpus callosotimy or vagal nerve stimulation
Temporal lobe
Extratemporal loca
= resection based
recording with func
localization
unitemporal
bitemporal
medial,
= amygdalotemporal resection
regional,
= second study
lateral,
= grid study to define onset
diffuse
= no surgery
cognitive, im
Wada unitem
= amygdaloter
resection
dominant temporal lobe
= AMTR if poor verbal memory
nondominant temporal lobe
= 6cm neocortical and AMTR

Anatomical Considerations

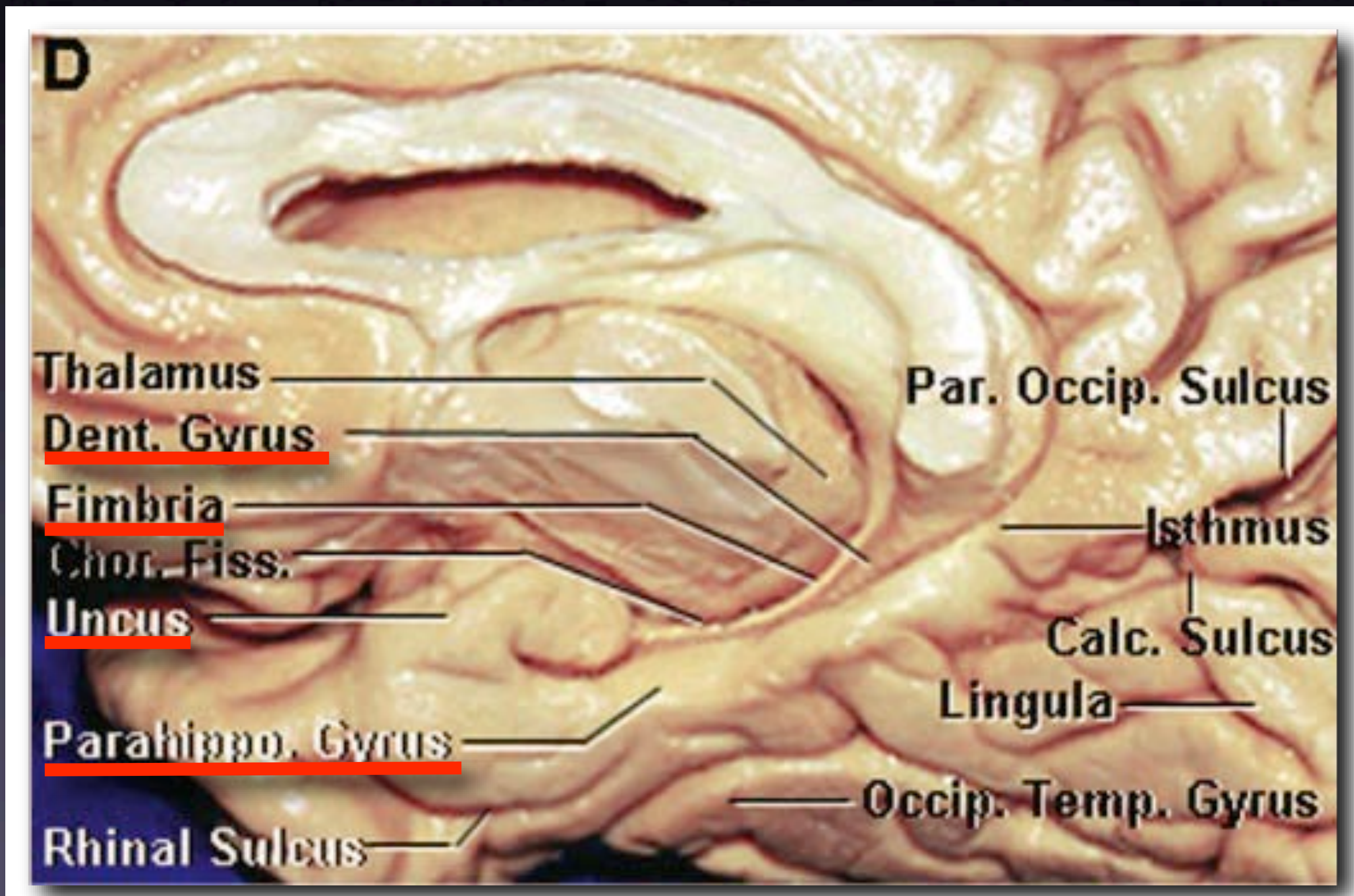
Lateral view of Temporal Lobe



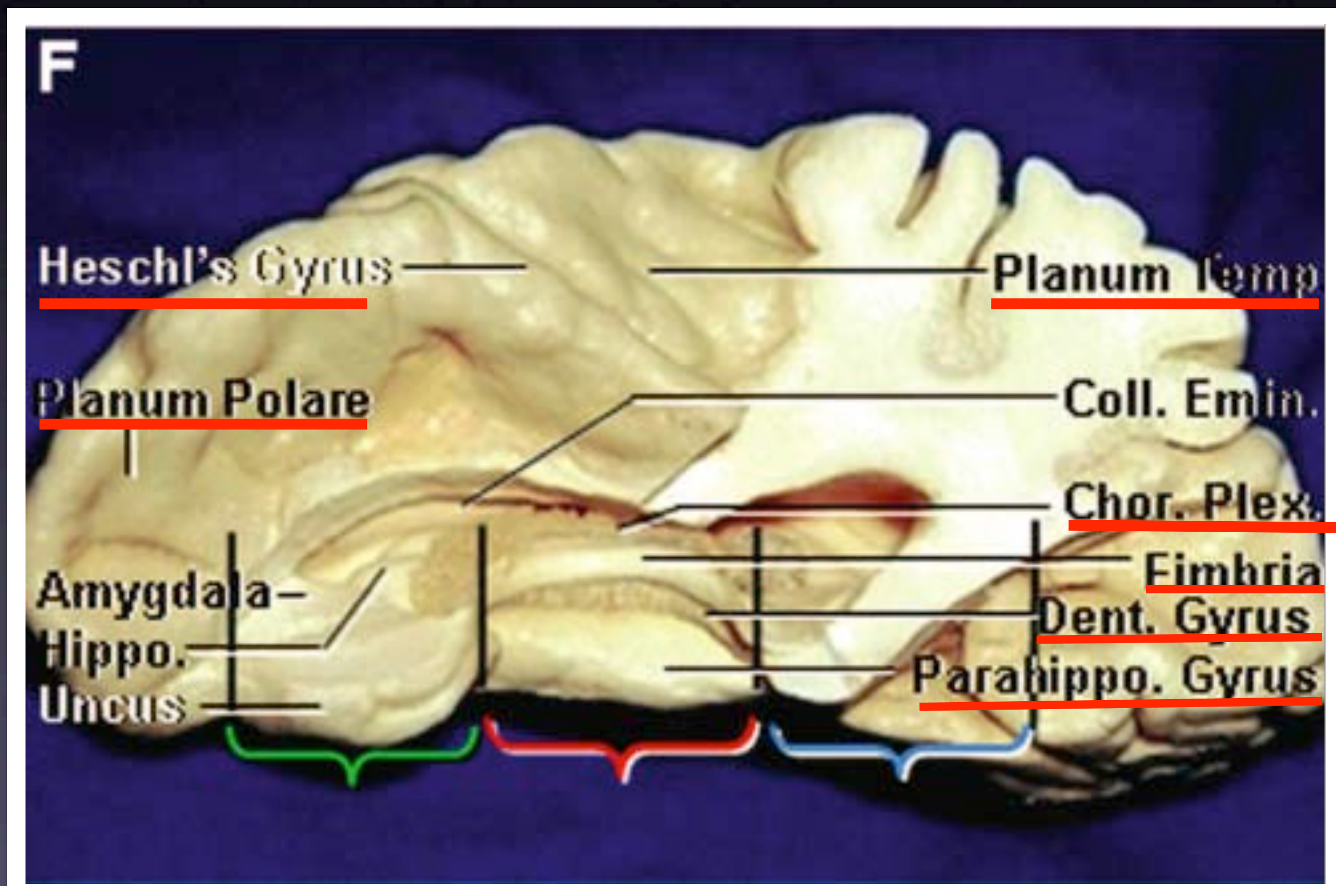
Basal surface of temporal lobe



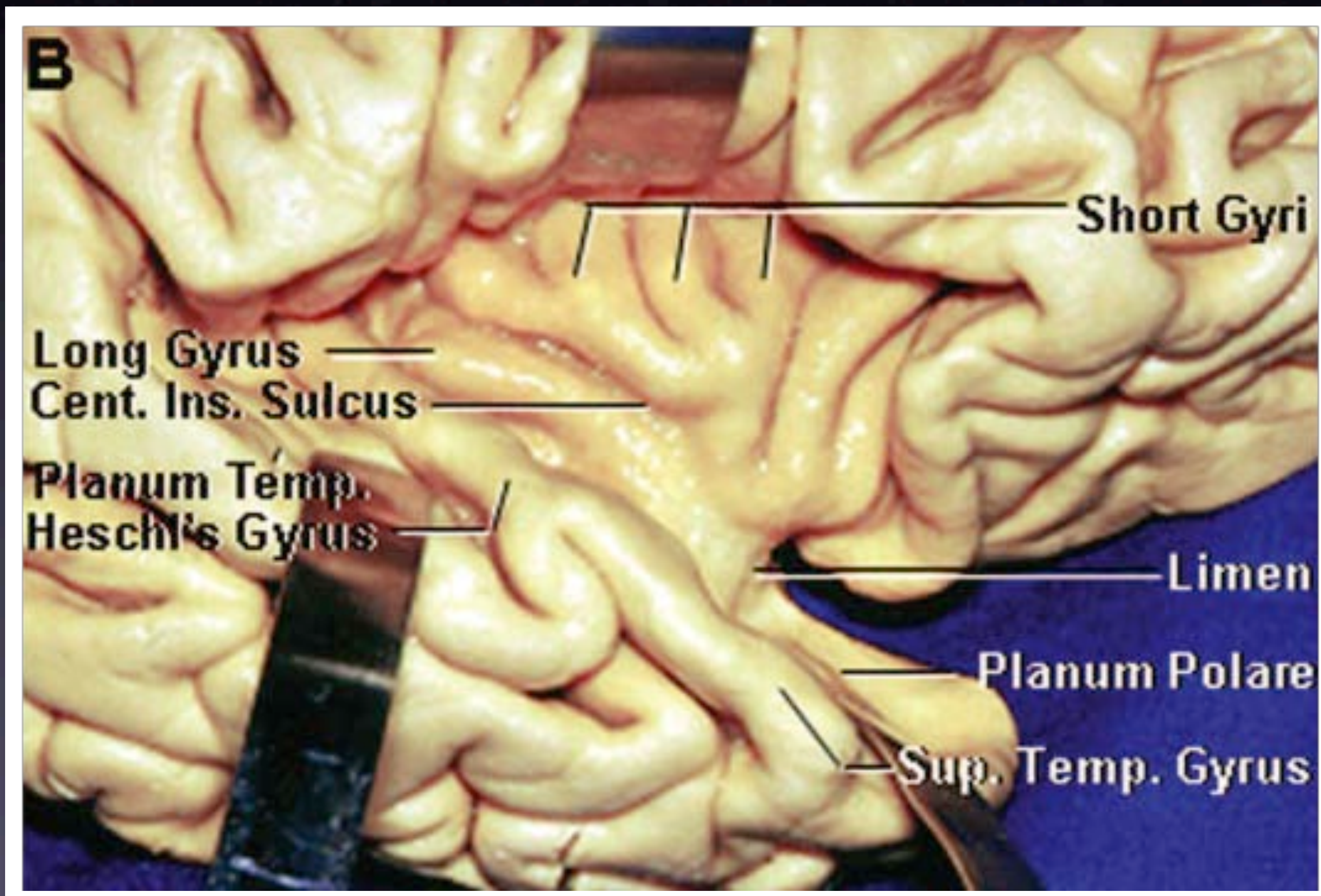
Medial Surface of the Temporal Lobe



Superior surface of the temporal lobe



Insular cortex



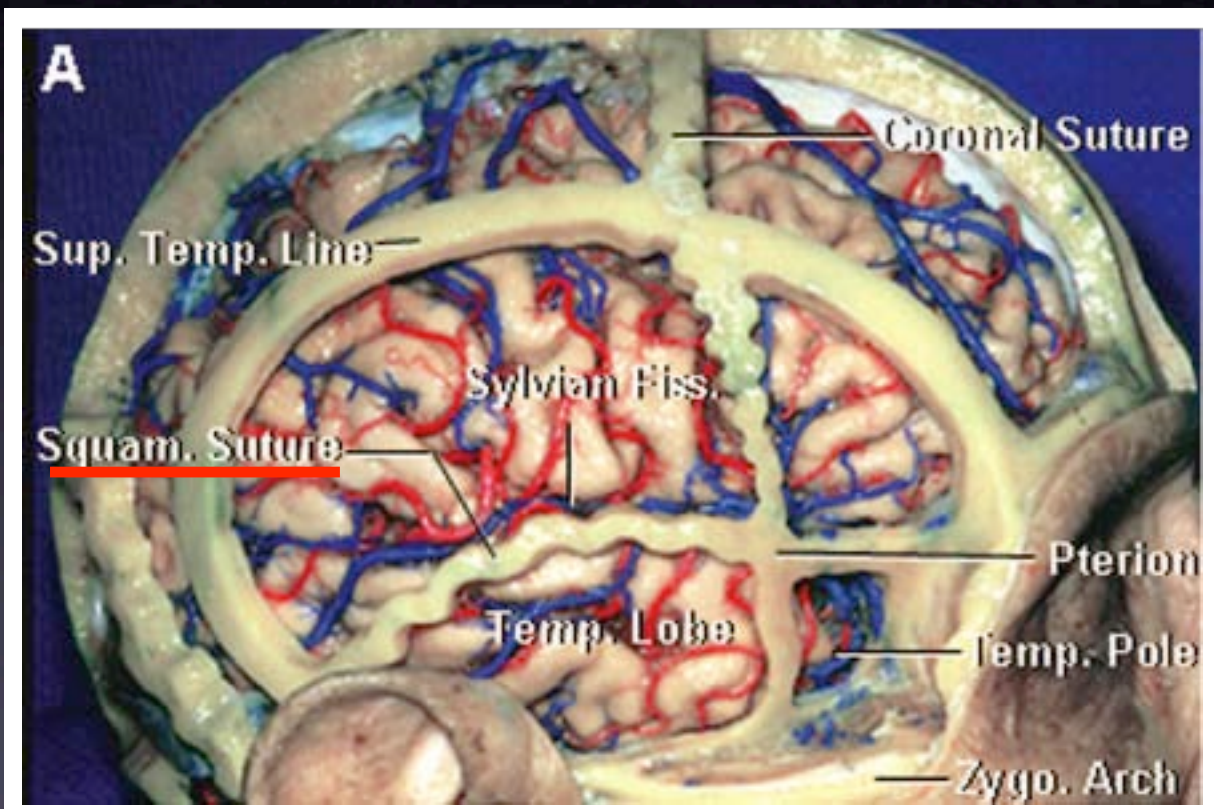
Surgical Approaches to the Temporal Lobe

Surgical Approaches...

Each surface of the temporal lobe lends itself to various surgical approaches...(not that I can DO ar
them!)

Surface	Surgical Approach
Anterior temporal lobectomy	
Lateral	transgyral approach
Superior	transsylvian-transinsular approach
Basal	transsulcal or transgyral approach
Medial	Anterior: transsylvian transcisternal approach Posterior: occipital interhemispheric and supracerebe transtentorial approach

Exposure



Patient should be positioned
head turned laterally to ~80 de
until zygoma is the most supe
point...question-mark shaped in
is made.

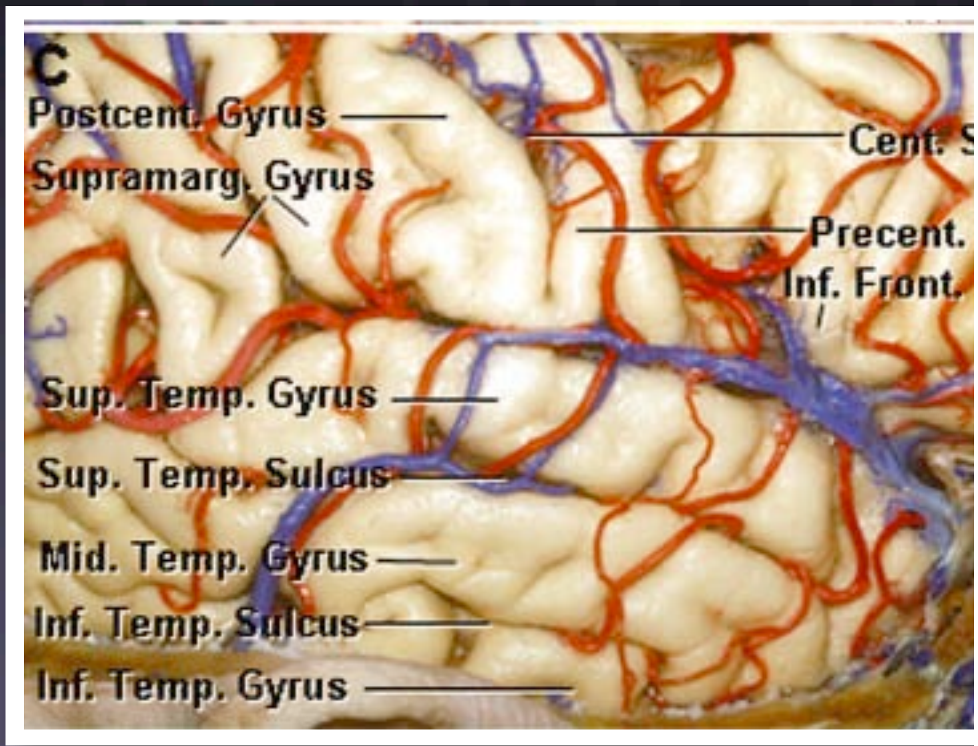
After mobilizing the temporalis
notice how the squamosal su
closely approximates the
anteroposterior orientation o
sylvian fissure.

~1cm of the lateral sphenoid
should be removed for
visualization of the sylvian fis
and inferior orbital frontal lo

Anterior Temporal Lobectomy

Lateral Neocortical Resection

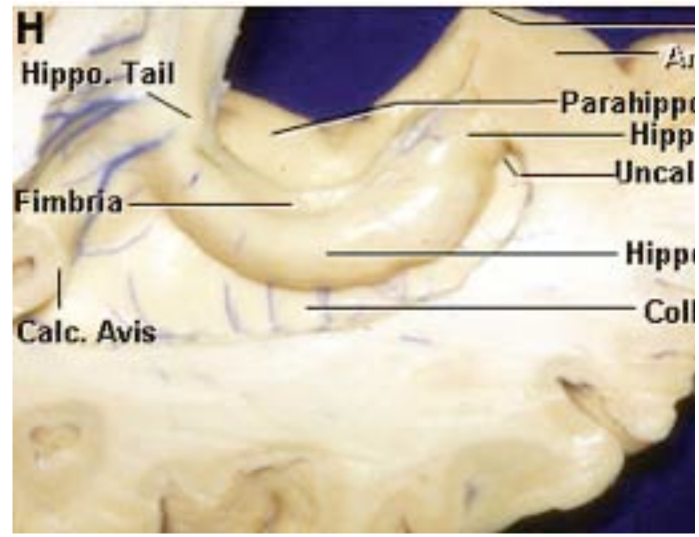
- arachnoid over middle temporal gyrus entered ~3-3.5cm posteriorly from the temporal pole
- incision carried into inferior temporal gyrus
- superior margin of resection limited to superior temporal sulcus

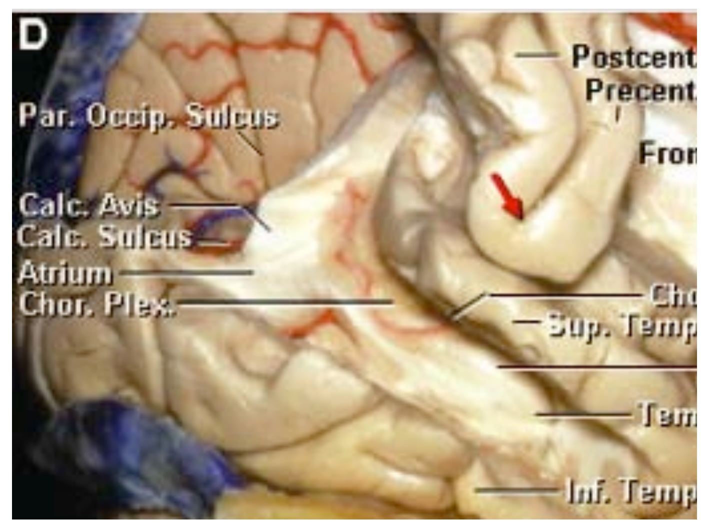


Anterior Temporal Lobectomy

Exposure of Temporal Horn and Hippocampus

- temporal horn lies deep to the middle temporal gyrus
- pes hippocampus seen as mass indenting medial surface of temporal horn - opposite to point of entry
- exposure of the hippocampus done by opening temporal horn to level of calcar avis via the fusiform gyrus
- stop resection where tail of hippocampus curves medially around quadrigeminal plate

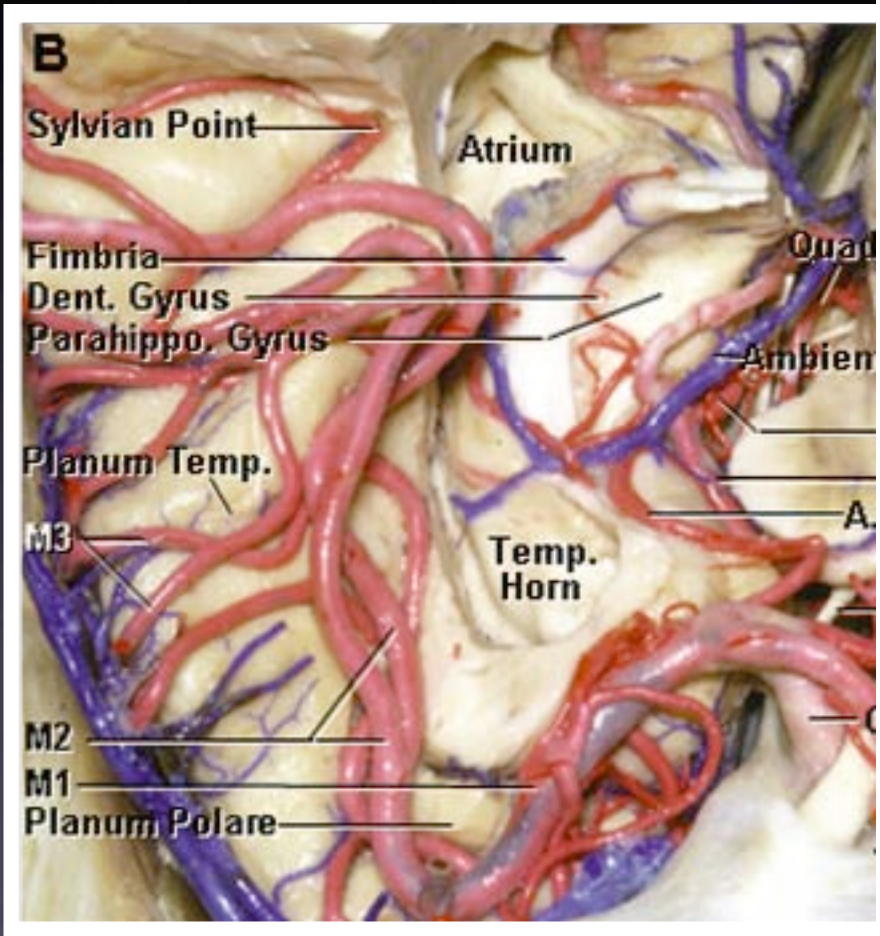




Anterior Temporal Lobectomy

Resection of the amygdala

- resection of the mesial structures begins with removal of inferior two-thirds of amygdala and uncus of parahippocampus
- incision from the tip of the temporal horn is directed anteromedially towards lesser wing of sphenoid
- resection is done very conservatively as the amygdala is continuous with the basal ganglia
- subpial dissection of amygdala will expose arachnoid overlying the tentorium, third nerve and PCA



Anterior Temporal Lobectomy

Mobilization of the hippocampus and the parahippocampal gyr

- first mobilize the parahippocampus along the collateral sulcus - this will help with more medial structures
- mobilization of the medial parahippocampal gyrus, hippocampus and fimbria require dissection along arachnoid over brain stem and thalamus
- hippocampus is released by cutting across its tail and should be delivered en bloc

Selective amygdalohippocampectom

- as more diagnostic tools became available, attention turned to the medial temporal structures as the predominant pathologic structures in epilepsy.
- there was some evidence of better _neuropsychological_ outcome with preservation of lateral neocortex
- as such, more selective procedures were developed which targeted selective removal of the mesial structures.

Indications for selective procedure

medically refractory epilepsy

unilateral localization to mesial struct

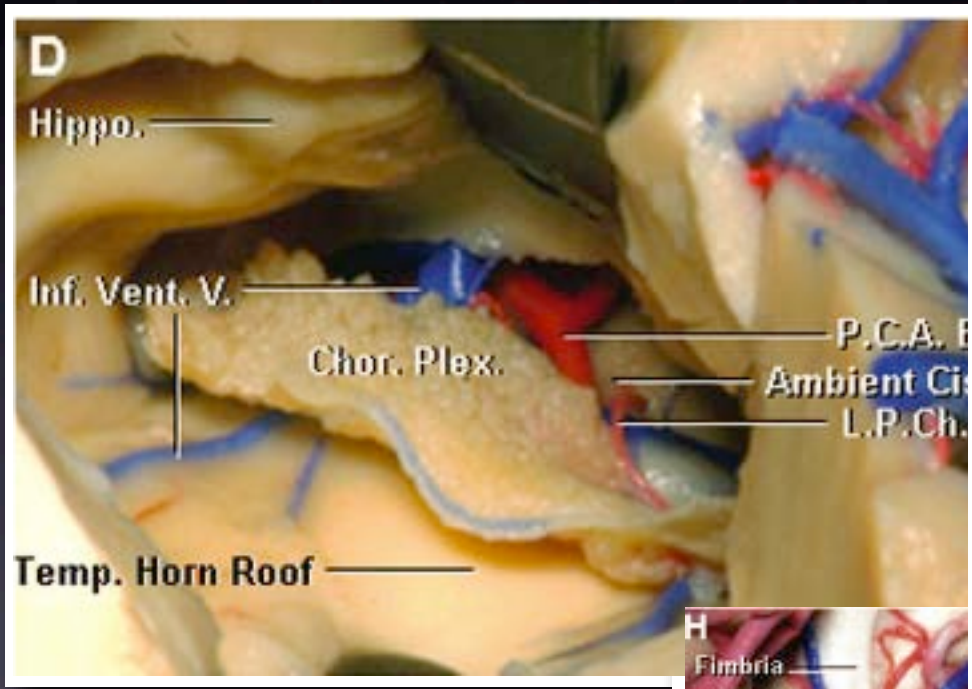
no evidence of extratemporal epilepti
activity on EEG

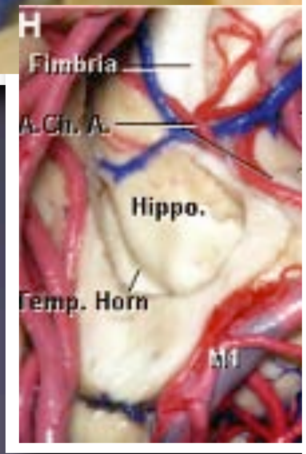
reasonable function of contralatera
temporal lobe

Lateral Approach: Transcortical amygdalohippocampectomy

<u>Access to temporal horn</u>

- temporal horn is accessed through middle temporal gyrus
- choroid plexus is displaced to the roof of the temporal horn
- choroidal fissure is opened through tenia fimbriae
- this provides access to ambient cistern

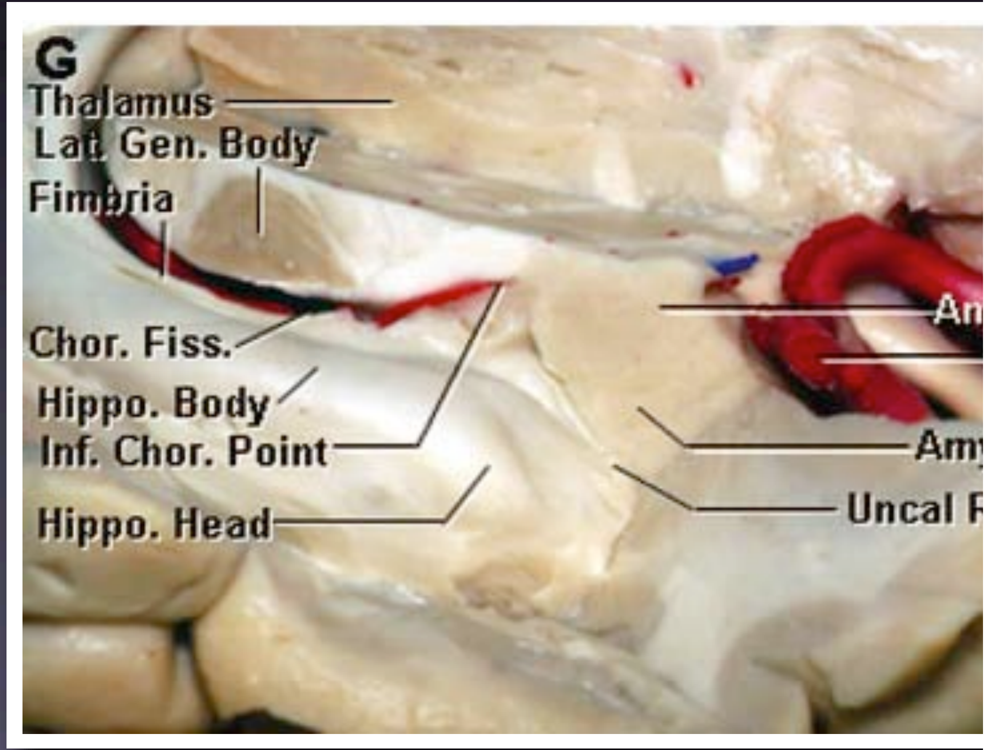




Lateral Approach: Transcortical amygdalohippocampectomy

Hippocampal Disconnection

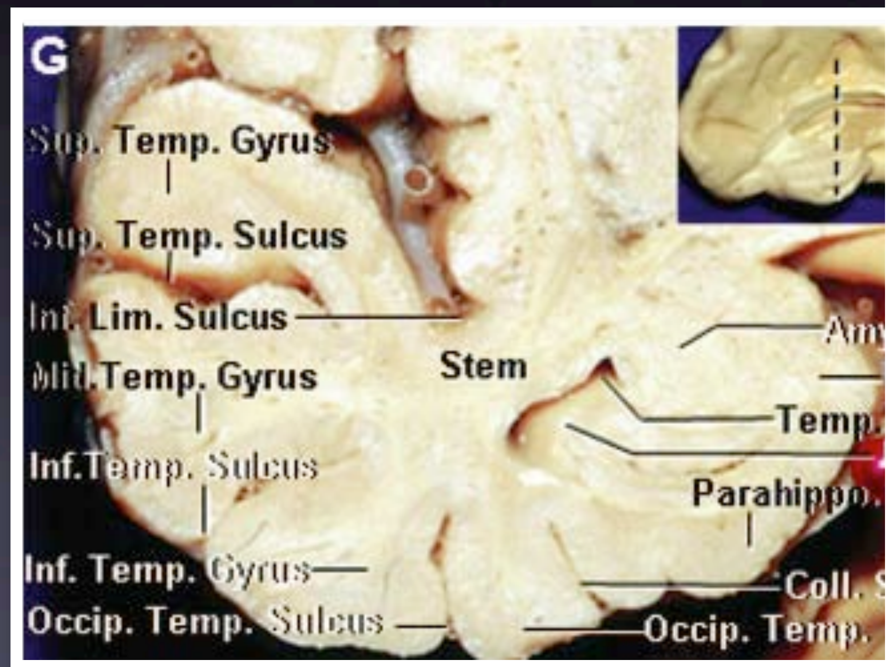
- after entry into the choroidal fissure, an icision is made around the hippocampus at the uncal recess down to collateral/rhinal sulci
- resection is carried posteriorly until tail of hippocampus reaches quadrigeminal plate
- this allows removal of the hippocampus en bloc



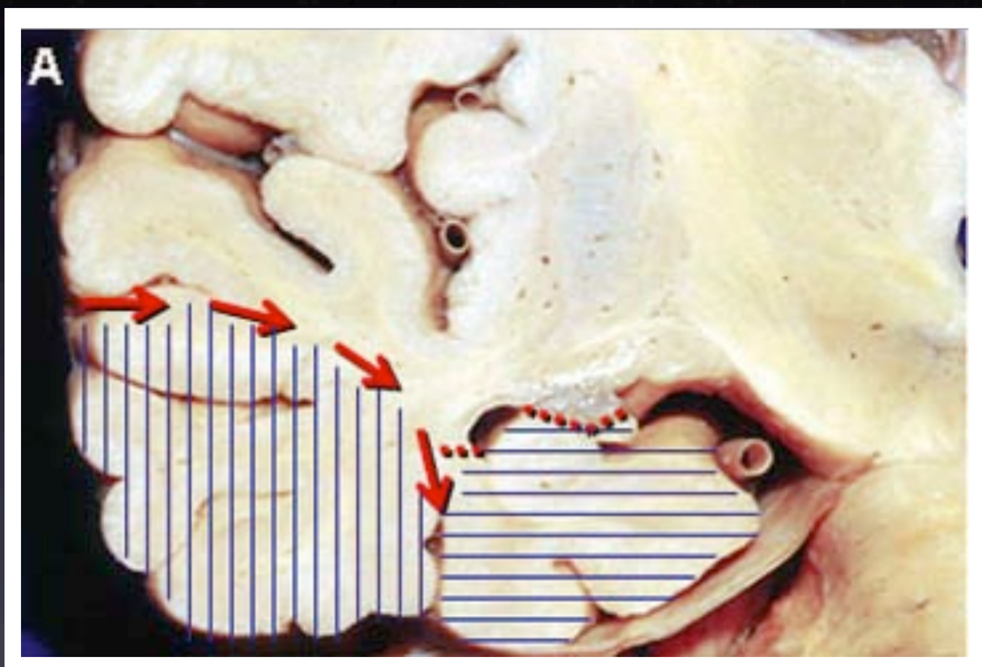
Lateral Approach: Transcortical amygdalohippocampectomy

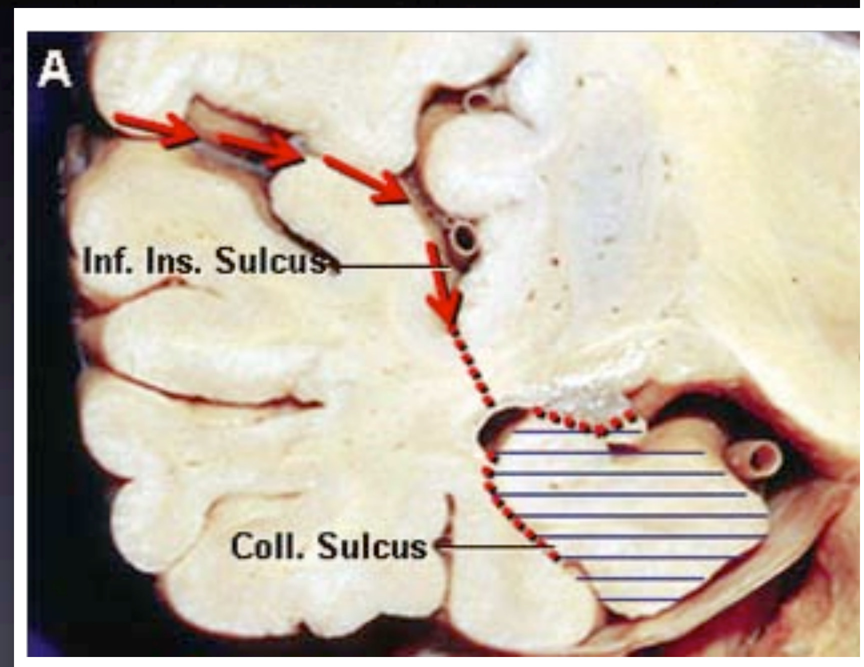
Removal of Amygdala

- the last step in the resection is the subpial resection of the remaining amygdala
- superior border of resection is the optic tract
- upper medial part of amygdala is continuous with the basal ganglia so a conservative resection is performed here



Summary of approaches





Anterior Temporal Lobectomy

Transcortical Amygdalohippocampectomy

Transsylvian Amygdalohippocampect

Risks of Surgery

Complications of Temporal Lobe Surgery

- transient dysphasias
- visual field deficits
- cranial neuropathies - CN II, III, V
- hemiparesis - damage to midbrain or cerebral peduncles
- tissue infarction from damage to MCA, PCA, anterior choroidal artery, posterior choroidal artery
- very low risk of mortality

Outcomes

Engel's outcome classification

I. Free of Disabling Seizures
- auras
- > 2 yrs seizure free

II. Rare Disabling Seizures
> 2yrs
nocturnal seizures only

III. Worthwhile improvement
>90% reduction for > 2yrs

IV. No worthwhile improvement
<90% seizure reduction

Seizure Outcomes Over Time

- one study followed post-operative patients for 5 yrs
- 55% of patients remained seizure free after 5 yrs
- of those who experienced seizures, 55% had seizures in first 6 months, 93% within the *first 2 years*

Outcomes in Patients with MTS

- in patients with unilateral MTS, and concordant presurgical evaluation, surgical outcomes are highly favourable
- ~90% patients had good outcomes
- with bilateral MTS - 62%

Outcomes for Anterior Temporal Lobectomy

- temporal lobe epilepsy is poorly controlled in 30% of patients despite best medical management
- Dr. Weibe's randomized control trial showed that for that uncontrolled population, 58% of people were seizure free with ATL vs 8% with continued medical management at 1yr.

Outcomes for ATL vs. SAH

- Initial data suggested improved neuropsychological testing with preservation of neocortex
- though no randomized trials have been done, current literature would suggest no difference in seizure control with either approach
- it is unclear whether selective approaches result in improved neuropsychological outcomes

Neuropsychological Outcomes

Cognitive Outcomes

- intellectual function generally preserved after temporal lobe resection
- may in fact improve if good seizure control is attained

Neuropsychological Outcomes

Global Memory Deficits

- global memory deficits uncommon ~1%
- hippocampal removal, rather than lateral neocortex, likely involved in global amnesia
- damage to fornix?

Neuropsychological Outcomes

Verbal Memory vs. Non-verbal Memory

- short problems with verbal memory common after dominant lobe resections
- preoperatively, weak performance on measures of verbal memory, young age at surgery, and operations on non-dominant side = IMPROVEMENT in verbal memory
- preoperatively weak nonverbal memory and left-sided operations = IMPROVEMENT in verbal memory
- good preoperative performance and older age = DETERIORATION in verbal memmory

Outcome for lesional epilepsy

- 85-92% seizure free rates in patients having temporal lobe lesion which was excised *along with mesial structures*
- other data suggests removal of lesion with adjacent cortical tissue and preservation of mesial structures provides good seizure control