

Speech and Language Assessment During an Awake Craniotomy

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Presenters

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Disclosures

- Sam Haider

- Paid Henry Ford Health System salary
- No other disclosures

- Timothy Carrier

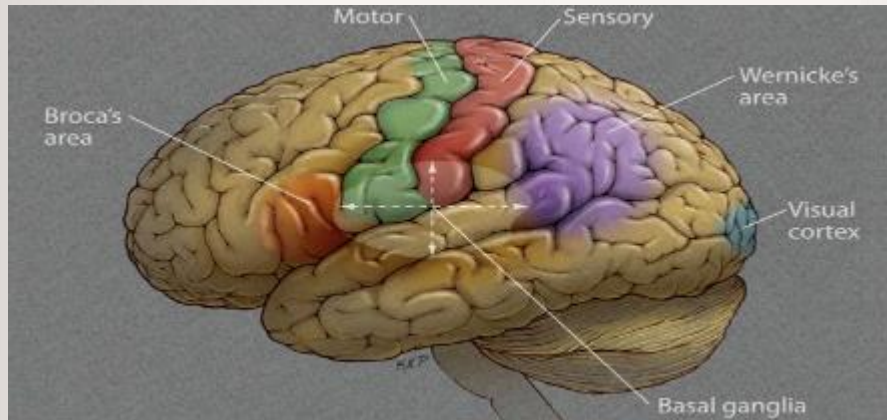
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Learning Objectives

- Identify what makes a patient an ideal candidate for an awake craniotomy with speech/language testing
- Evaluation of a patient prior to surgery
- Evaluation of a patient during surgery and what to expect post-op

Who needs an awake surgery?

- Best utilized for surgeries in or near 'eloquent areas'
- Eloquent: areas essential to sensorimotor and linguistic processing

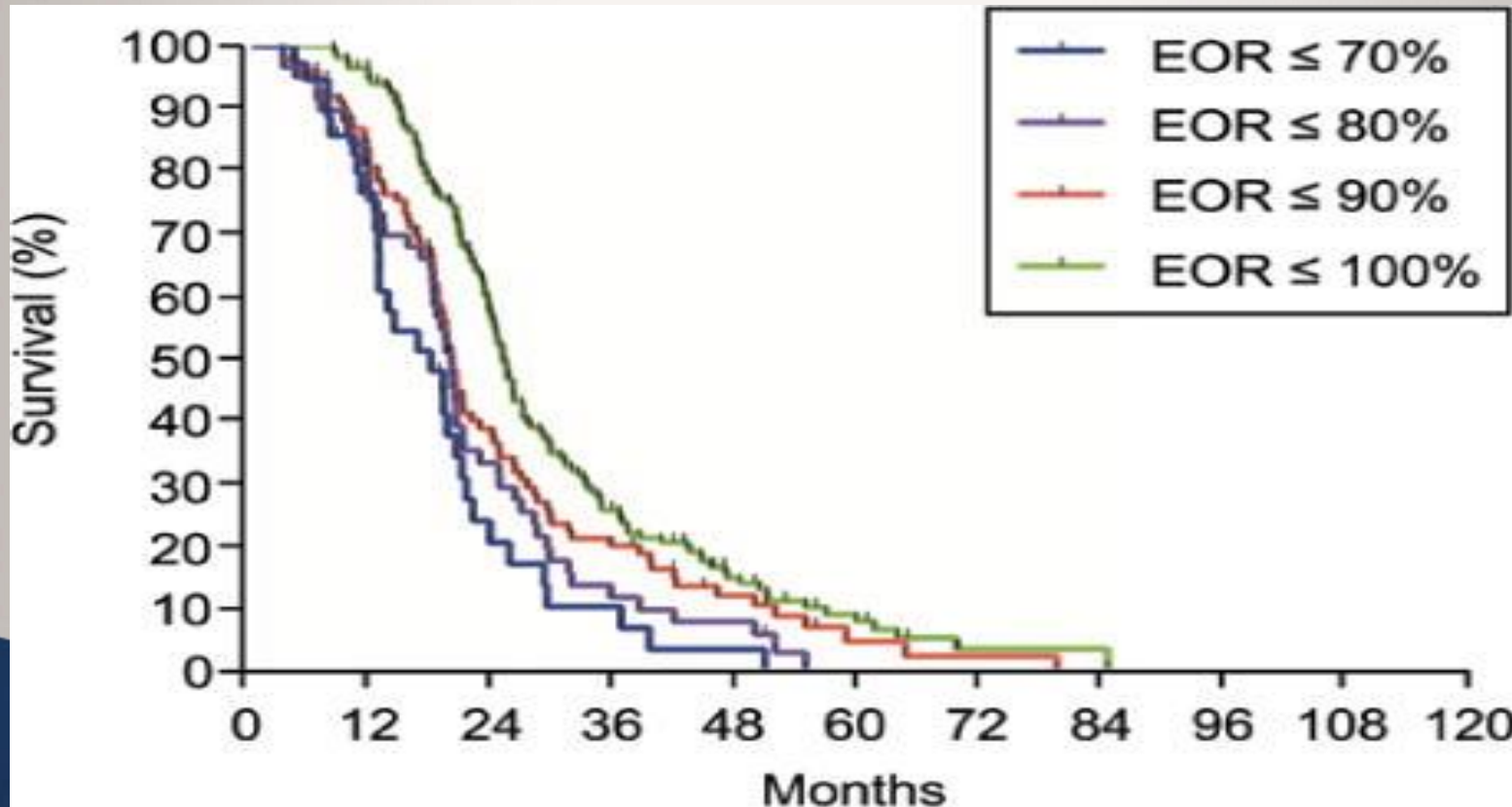


Most common indications

- Tumor resection
- Epileptic focus resection
- Vascular lesions
- Movement disorders

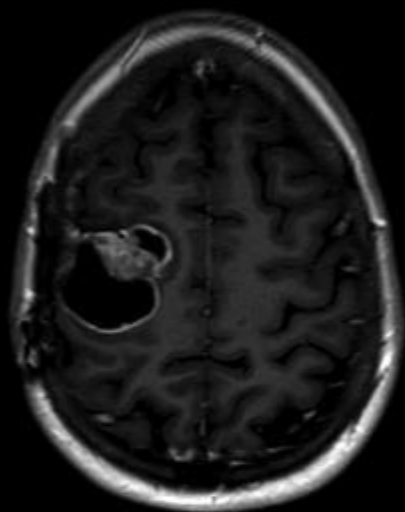
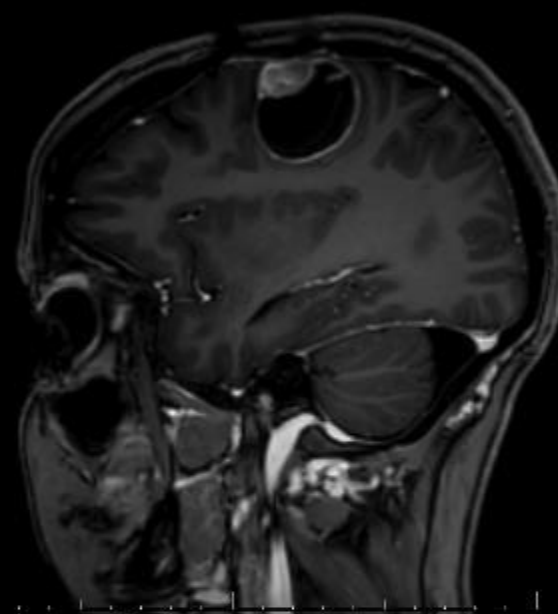
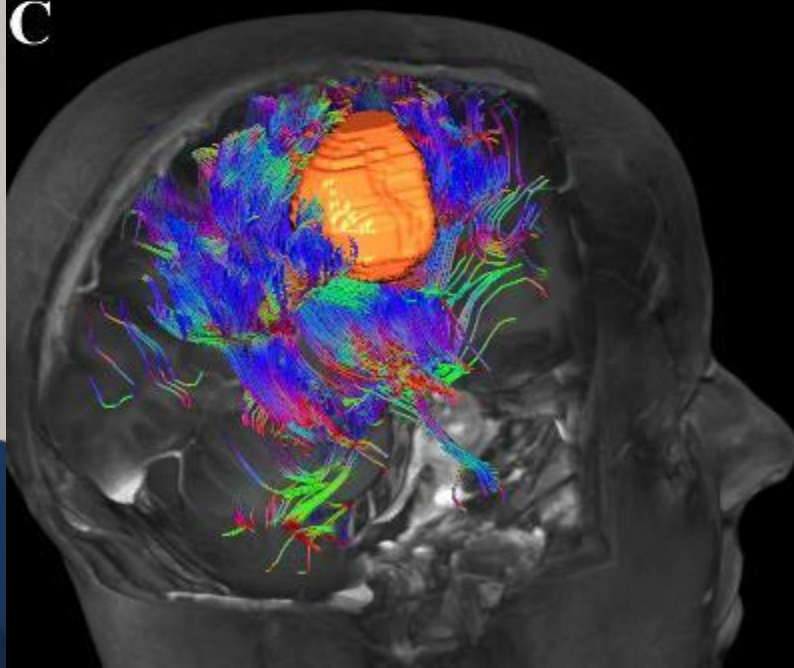
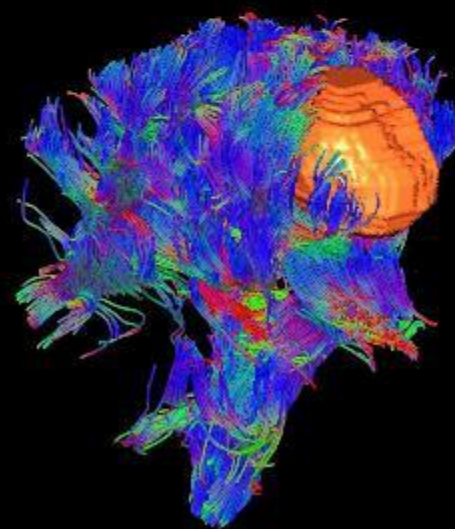
Why not just take out the abnormal stuff?

- Pathologic / functional boundary is blurred
- Extent of resection improves outcomes



Why not just take out the abnormal stuff?

- Intraop mapping helps distinguish and preserve functional areas
- Plan the safest transcortical route to the lesion
- Be more aggressive at tumor boundaries while respecting functional tissue

A**B****C****D**

Firm contraindications

- Airway concerns
- Claustrophobic / anxious patient
- Underlying cognitive disorder

Relative contraindications

- Obstructive sleep apnea
- Difficult to control seizures
- Body habitus / positioning
- Language barrier

CNS Modalities we can test while awake

- Motor
- Speech
 - Subfunctions
 - Motor aspects of elocution
 - Linguistic processing
- Vision
- Understanding

Workflow / Setup

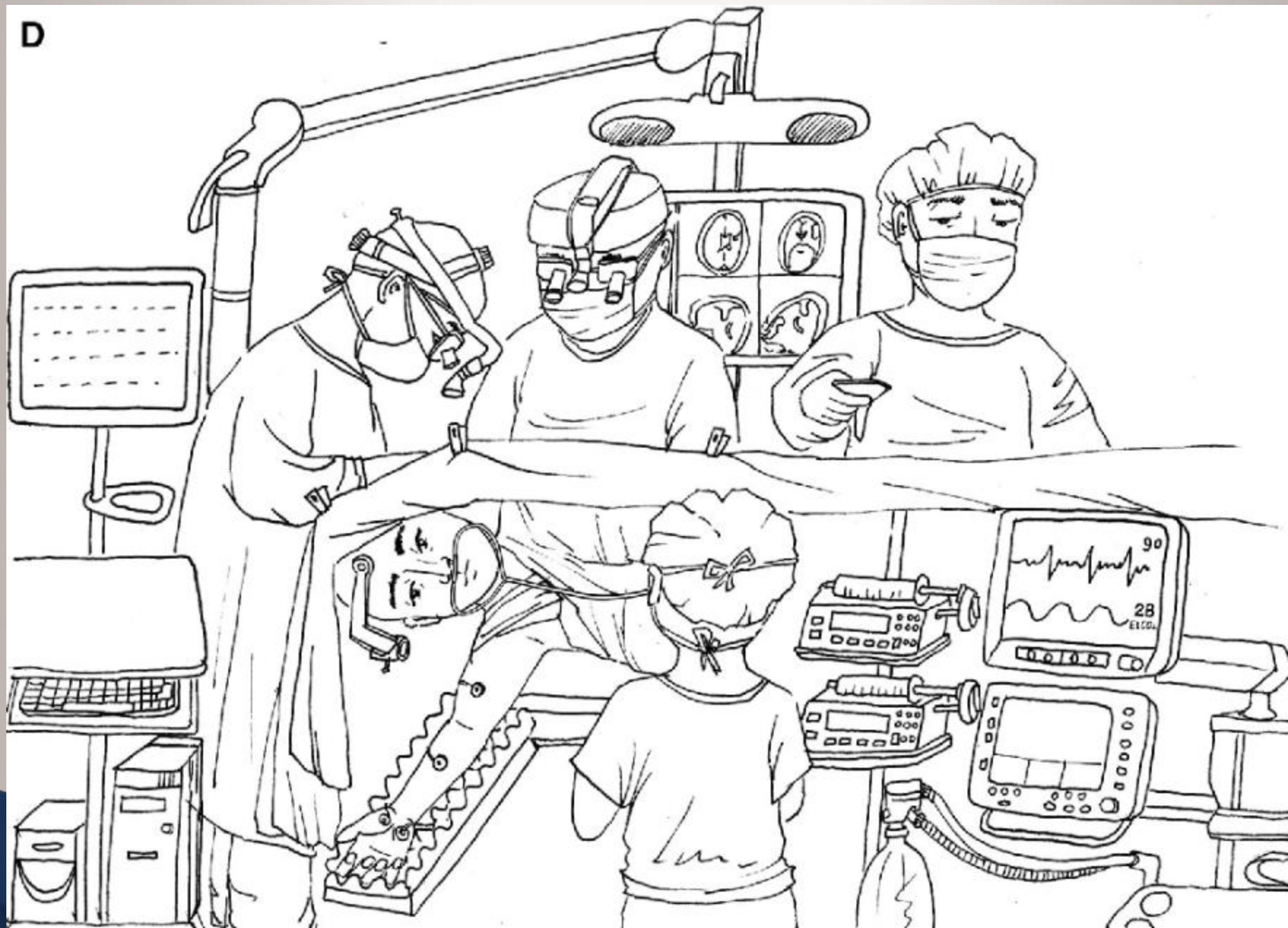
- Preoperative assessment/baselines (days prior)
- Local scalp / pin block
- Asleep - Awake - Asleep



Full House!

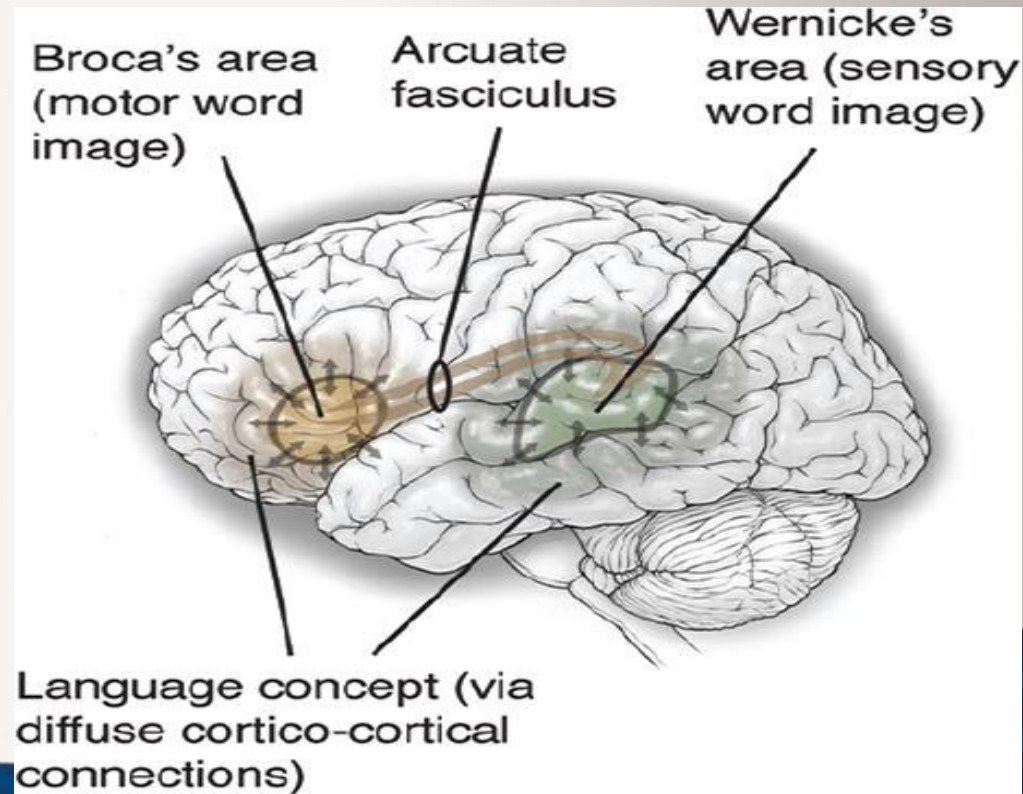
- Patient
- Surgeon / resident(s)
- RN Circulator
- Scrub technician (s)
- Anesthesiologist / resident(s) / CRNA(s)
- SLP team members
- Neurophysiologist
- Neuromonitoring technician
- +/- adjunct device/drug rep(s)
- +/- neuronavigation rep
- Microscope (bigger than a full-size kangaroo)
- And Lots of equipment for each person!

D



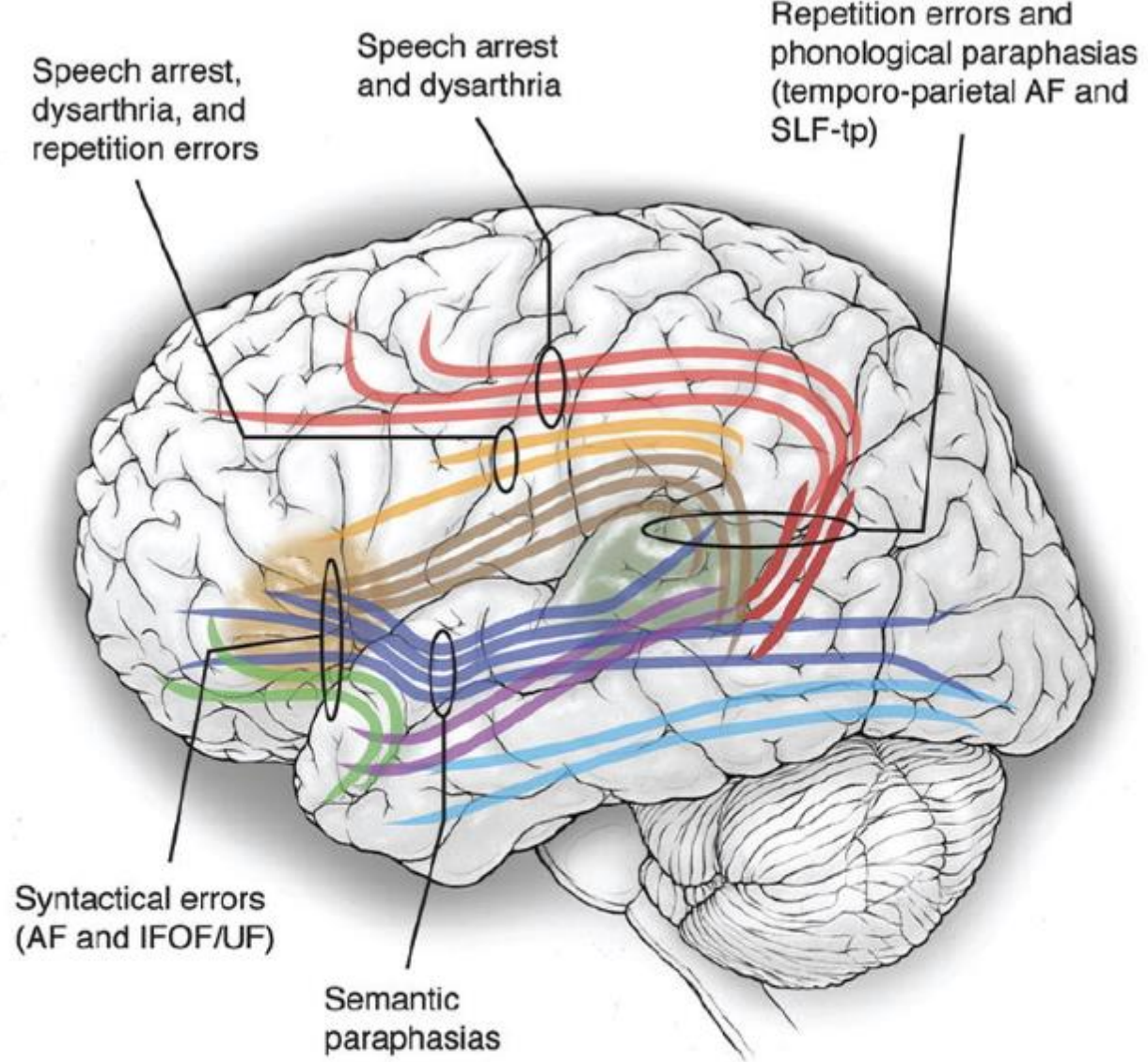
Brain Mapping: Language

- Before the actual 'brain' part of the surgery even starts
- Direct electrical stimulation during an assortment of different language tasks
- Tells us → don't cut here
- Broca's area
- Wernicke's area



That's just the surface...

- Besides testing the brain cortex, the eloquent functional areas are connected to other areas of the brain beneath the brain surface



- | | |
|---|---|
| ■ Superior longitudinal fasciculus (SLF) II | ■ SLF III |
| ■ Inferior fronto-occipital fasciculus (IFOF) | ■ Arcuate fasciculus (AF) |
| ■ Middle longitudinal fasciculus | ■ SLF-tp |
| ■ Inferior longitudinal fasciculus | ■ Uncinate fasciculus (UF) |

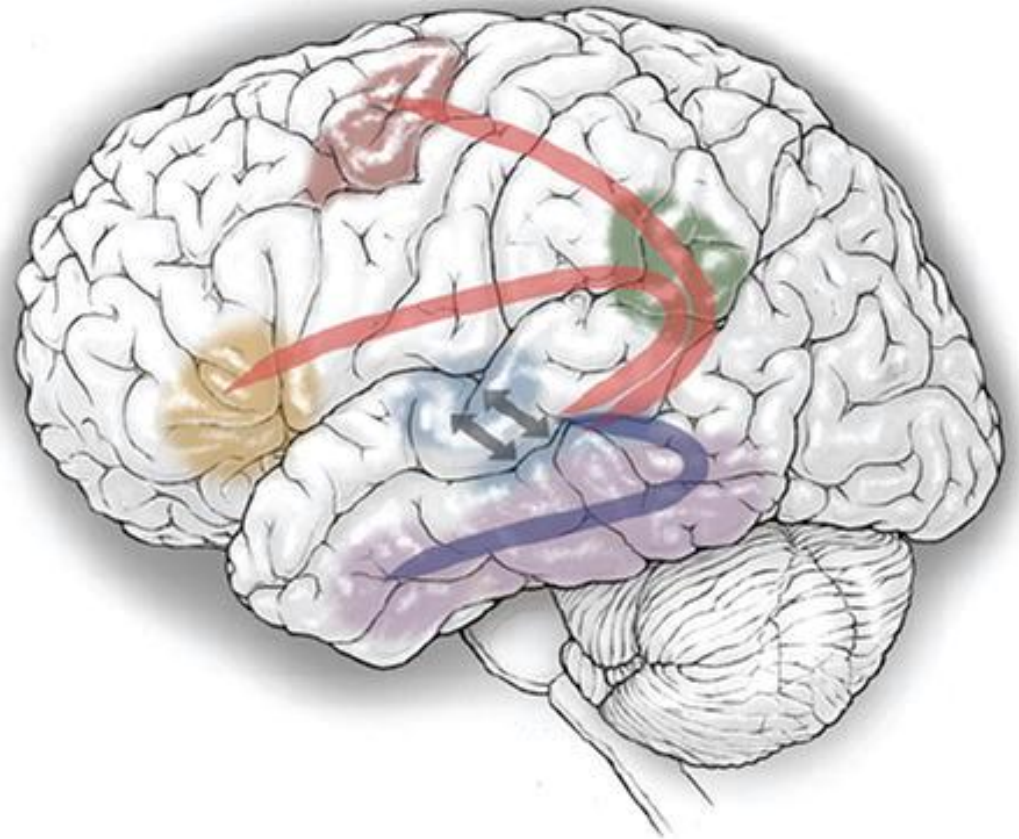
HF Workflow and typical positioning

- Lateral decubitus, unobstructed line of sight, adequate padding / position of comfort
- Asleep → incision and craniotomy → dural opening → Awake patient and call Tim!
- Assess patient comfort before proceeding

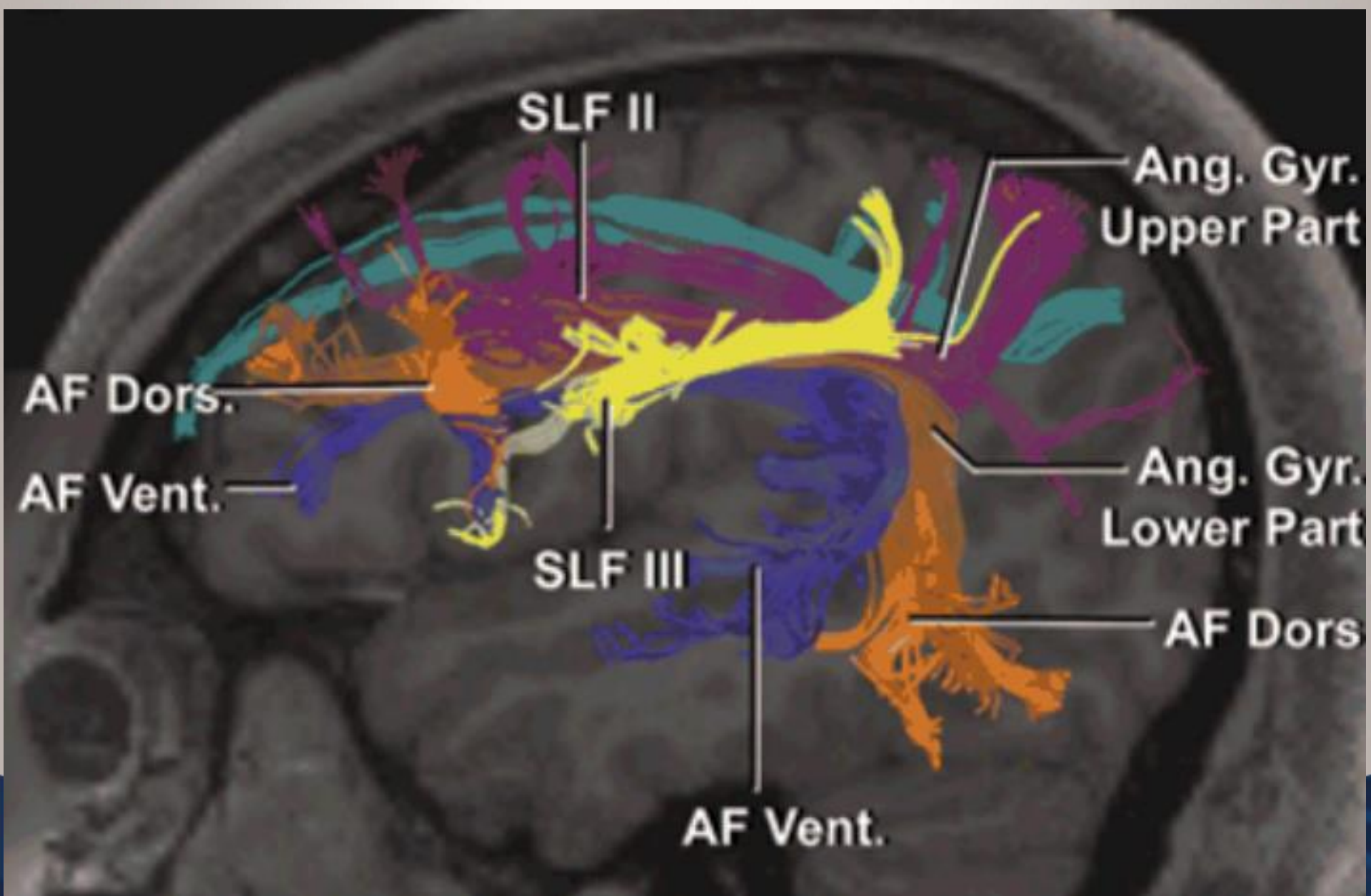
Things we are looking for:

- Counting
- Naming
- Anarthria / speech arrest
- Dysarthria
- Anomia
- Paraphasia
- Articulatory disturbance

Awake mapping
+ anatomic knowledge
+ tumor morphology
= tailored surgical
corridor respecting
normal brain and
allowing maximal safe
resection



- Dorsal stream for sensorimotor integration (mostly dominant)
- Ventral stream for speech comprehension (bilateral)



SLF II

Ang. Gyr.
Upper Part

AF Dors.

Ang. Gyr.
Lower Part

AF Vent.

SLF III

AF Dors.

AF Vent.

TABLE 1. Fiber tract connections, functions, and associated disconnection syndromes

Fiber Tract	Interconnected Regions	Functional Role		Disconnection Syndromes
		Dominant Hemisphere	Nondominant Hemisphere	
SLF I	Precuneus w/ ant cingulate cortex	Regulation of higher aspect of motor function; initiation of motor activity; ^{43,55,64} activation in resting state; ^{10,74} integrate internally & externally driven information ^{10,74}	Regulation of higher aspect of motor function; initiation of motor activity; ^{43,55,64} activation in resting state; ^{10,74} integrate internally & externally driven information ^{10,74}	Unknown
SLF II	Ant part of the mid occipital lobe or angular gyrus w/ mid frontal gyrus	Visual spatial awareness & attention ^{68,69}	Visual spatial awareness & attention ^{68,69}	Spatial working memory disorders (neglect syndrome) ⁶⁸
SLF III	Supramarginal gyrus w/ pars opercularis	Articulatory aspects of language ^{25,43,45,46,62}	Visuospatial attention, prosody, & music processing ^{32,41,63,68}	Articulatory disorders (dysarthria/anarthria) ^{25,43,45,46,62}
AF ventral	Mid & pst part of the superior temporal gyrus & mid part of mid temporal gyrus w/ ventral premotor cortex, pars opercularis, & triangularis	Phonological language processing ^{24,30*}	Phonological language processing ^{24,30}	Phonological paraphasia & repetition disorder ^{24,30}
AF dorsal	Pst parts of the mid & inferior temporal gyri w/ ventral premotor cortex, pars opercularis, & pst part of the mid frontal gyrus	Lexical & semantic language processing ^{24,30†}	Prosodic activation of language ^{24,30‡}	Transcortical motor aphasia ^{24,30}

Ant = anterior; mid = middle; pst = posterior.

* Phonemes are the smallest unit of sound in spoken language.

† Lexical-semantics denotes the concepts and meaning of words and vocabulary of words associated with these meanings.

‡ Prosody consists of nonverbal aspects of speech that convey additional meaning (i.e., rhythm, tone, volume, tempo).

Video

Common Questions

- Does it hurt?
- Do patients remember it?
- If speech gets worse after surgery, will it recover?
- What if there's a seizure during surgery?

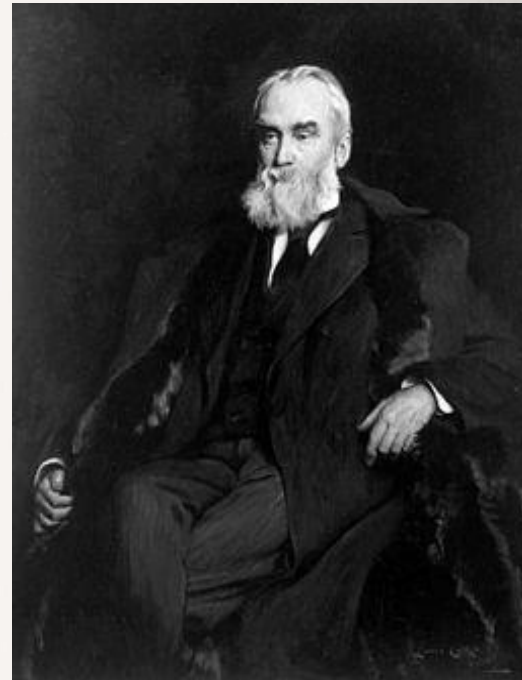
History

- Archeological findings demonstrate that patients were treated by trepanation (burr hole) for seizures thousands of years ago.



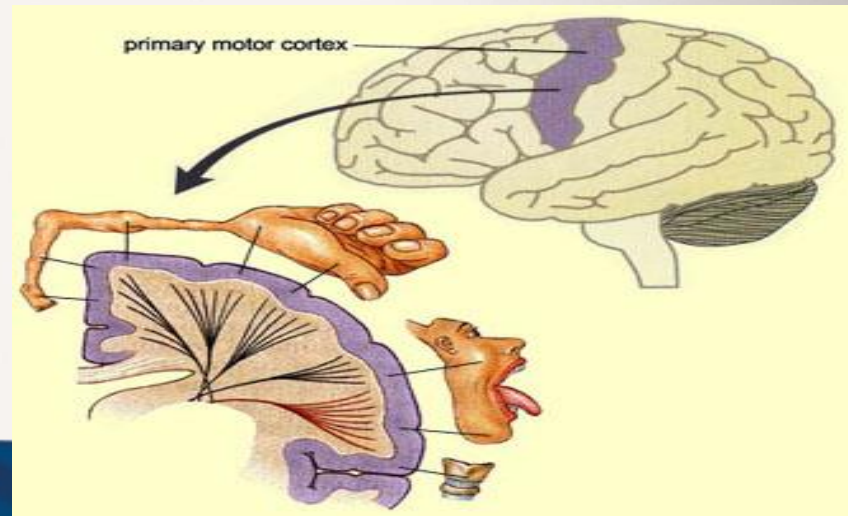
History

- John Hughlings Jackson did a study of focal epilepsy between 1864 – 1870, and he predicted that an area existed in the cerebral cortex that controlled isolated movements.



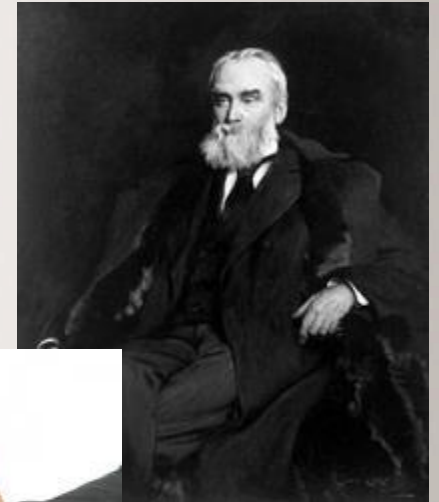
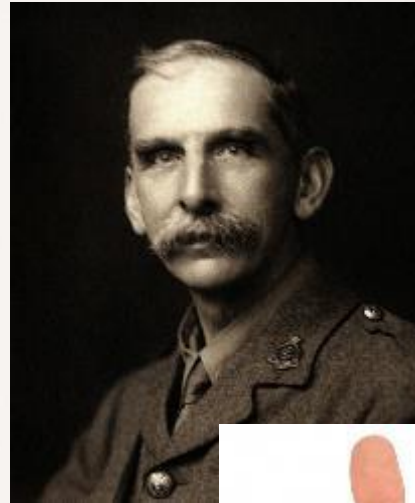
History

- Gustav Theodore Fritch and Eduard Hitzig in 1870, elicited movements in the extremities of animals with electrical stimulation on the cerebral cortex
- Identified the primary motor cortex “motor strip”



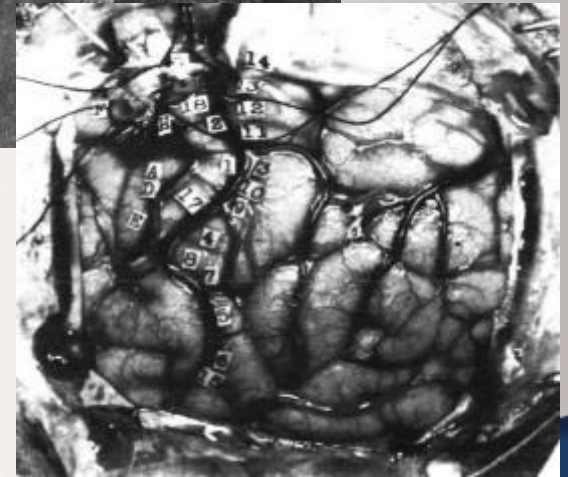
History

- In 1886, Victor Horsley and colleague John Hughlings Jackson had a patient with seizures that would begin the left thumb
- Based on previous research, they applied electrical stimulation to localize the thumb area and excised this as it was the source of the seizure



History

- In the 1920s, Wilder Penfield was treating patients with intractable epilepsy. He knew that patients experienced an “aura” prior to an epileptic seizure. He identified the area of seizure of activity by inducing this “aura” with electrical stimulation with an awake patient. The source would then be removed.
- In 1950, intraoperative stimulation was also performed by Penfield to determine speech function.



History

- Within the past several decades, brain mapping techniques using electrical stimulation have been used to help identify language regions and other eloquent areas to be preserved in brain tumor surgery.

Other Important Players

- Paul Broca, June 28, 1824 – July 9, 1880
 - French physician
 - Hypothesized that speech production was located in the left frontal lobe of the brain – inferior frontal gyrus



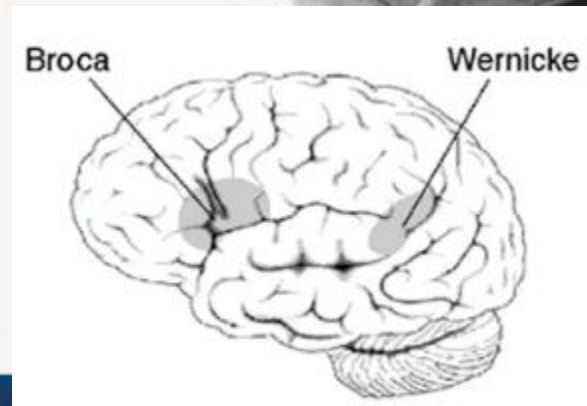
Other Important Players

- Met with a patient, Louis Victor Leborgne who had a progressive loss of speech. He was only able to say, “tan,” but his comprehension was intact. Upon autopsy, the lesion was located in left frontal lobe
- Broca went on to study several more cases of impaired speech production but intact comprehension with lesions localized in the same area



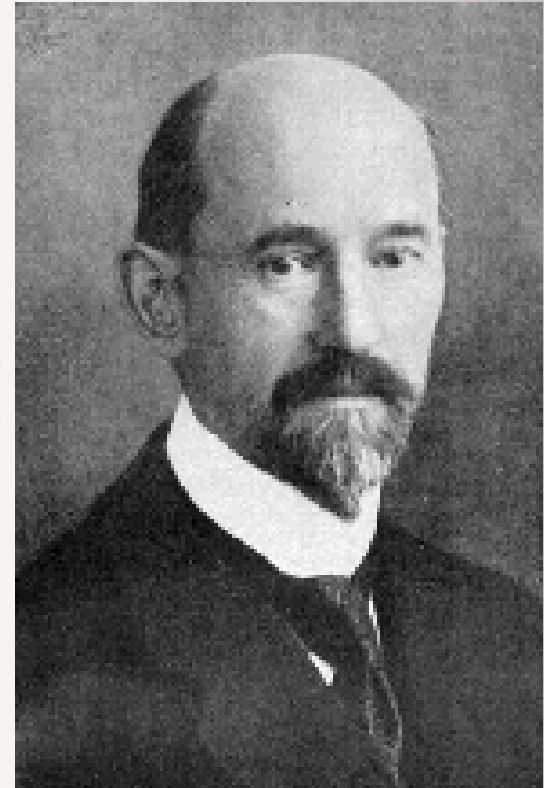
Other Important Players

- Carl Wernicke, German physician, May 5, 1848 – June 15, 1905
 - Described “sensory” aphasia related to lesion in the left posterior temporal lobe



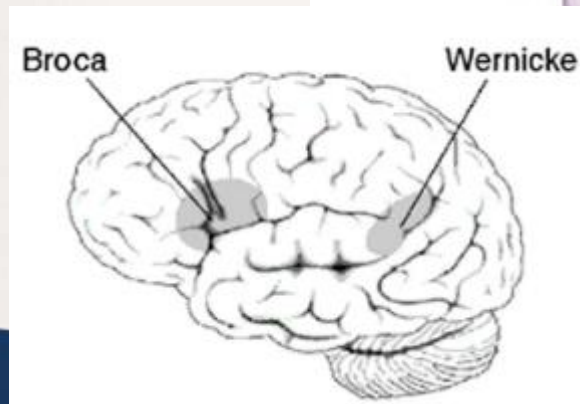
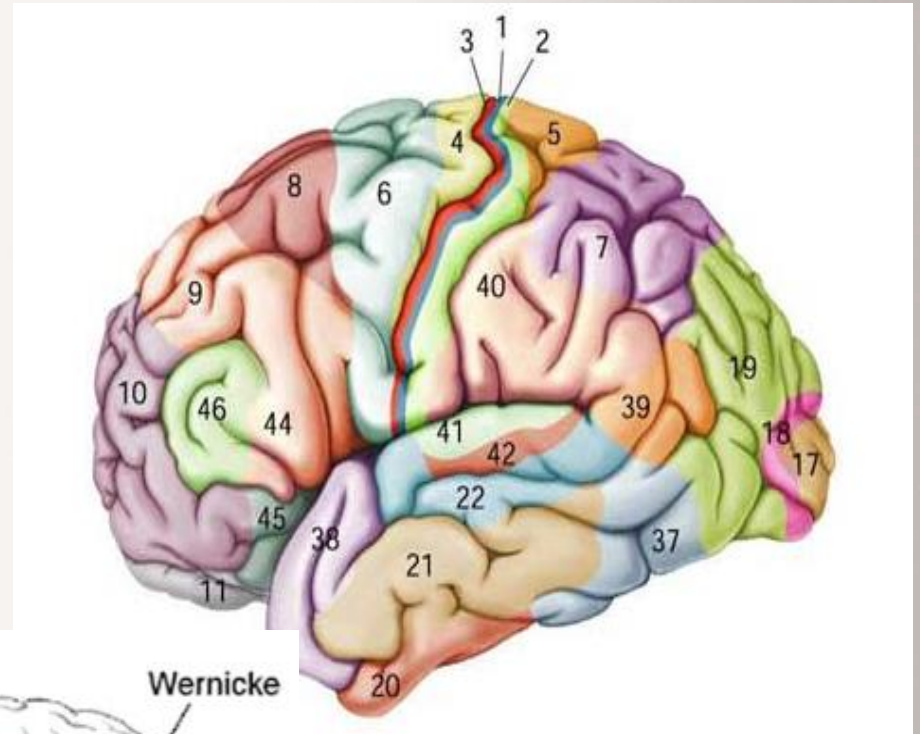
Other Important Players

- Korbinian Brodmann, German Neurologist, November 17, 1868 – August 22, 1918
 - Divided the brain into 52 distinct areas; he hypothesized that these areas performed different functions



Other Important Players

- Broca's area pertains to Brodmann area 44 and 45
- Wernicke's area pertains to Brodmann area 22



Awake Craniotomy Benefits

- A total of 8 studies with 951 patients were included in this review to examine the benefits and limitations of using awake craniotomy (AC) over general anesthesia (GA).
 - AC results in shorter hospital stay (4 days vs. 9 days)
 - One study involved AC as outpatient procedure with 89.1% of those 46 patients begin discharged the same day
 - Post-operative deficits were less frequent under awake craniotomy (23% in GA vs 7% in AC)

- Brown, T., Shah, A. H., Bregy, A., Shah, N. H., Thambuswamy, M., Barbarite, E., ... Komotar, R. J. (2013). Awake craniotomy for brain tumor resection: The rule rather than the exception? *Journal of Neurosurgical Anesthesiology*, 25(3), 240-247. <https://doi.org/10.1097/ANA.0b013e318290c230>

The Pre-Op Speech and Language Evaluation

- Education, Counseling, and Expectations
- Oral Motor Examination
- Picture Card Naming
- Conversation Topic Generation
- Standardized Assessments

The Pre-Op Speech and Language Evaluation

- Education, Counseling, and Expectations
 - 70 patients scheduled to undergo an awake craniotomy were given the Hospital Anxiety and Depression Scale (HADS).
 - 25% of these patients suffered a significant level of anxiety prior to their awake surgery (HADS > 7)
 - Ruis, C., Wajer, I. H., Robe, P., & Zandvoort, M. V. (2017). Anxiety in the preoperative phase of awake brain tumor surgery. *Clinical Neurology and Neurosurgery*, 157, 7-10. doi: 10.1016/j.clineuro.2017.03.018

The Pre-Op Speech and Language Evaluation

- Education, Counseling, and Expectations
- Most patients are horrified when the idea of awake craniotomy is first presented to them. However, with repeated reassurance and careful explanation, the patients have confidence with the team
 - Jääskeläinen, J., & Randell, T. (2003). Awake Craniotomy in Glioma Surgery. *Local Therapies for Glioma Present Status and Future Developments*, 31–35. doi: 10.1007/978-3-7091-6090-9_6

The Pre-Op Speech and Language Evaluation

- Education, Counseling, and Expectations

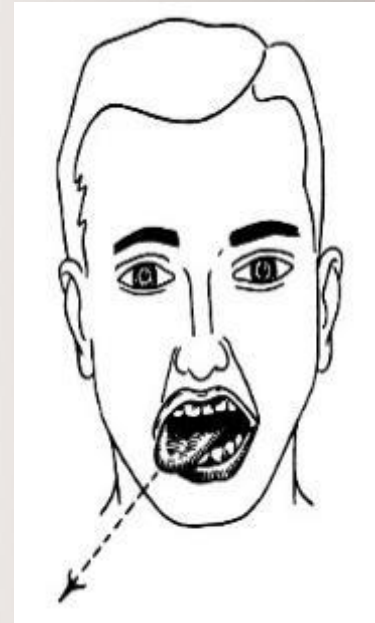


The Pre-Op Speech and Language Evaluation

- Education, Counseling, and Expectations
 - Review who you are and role
 - What does the patient know?
 - Simple anatomy and speech/language
 - What you will be doing today
 - What to expect day of surgery and in the operating room
 - What to expect after surgery

The Pre-Op Speech and Language Evaluation

- Oral Motor Examination
 - Assessing strength, range of motion, appearance, and motor function of the visible structures involved with speech and swallowing
 - Important to be aware of pre-op weakness and/or abnormalities prior to surgery



The Pre-Op Speech and Language Evaluation

- Picture Card Naming
 - These are the items that the patient will be naming intra-op
 - Picture cards are simple black and white pictures

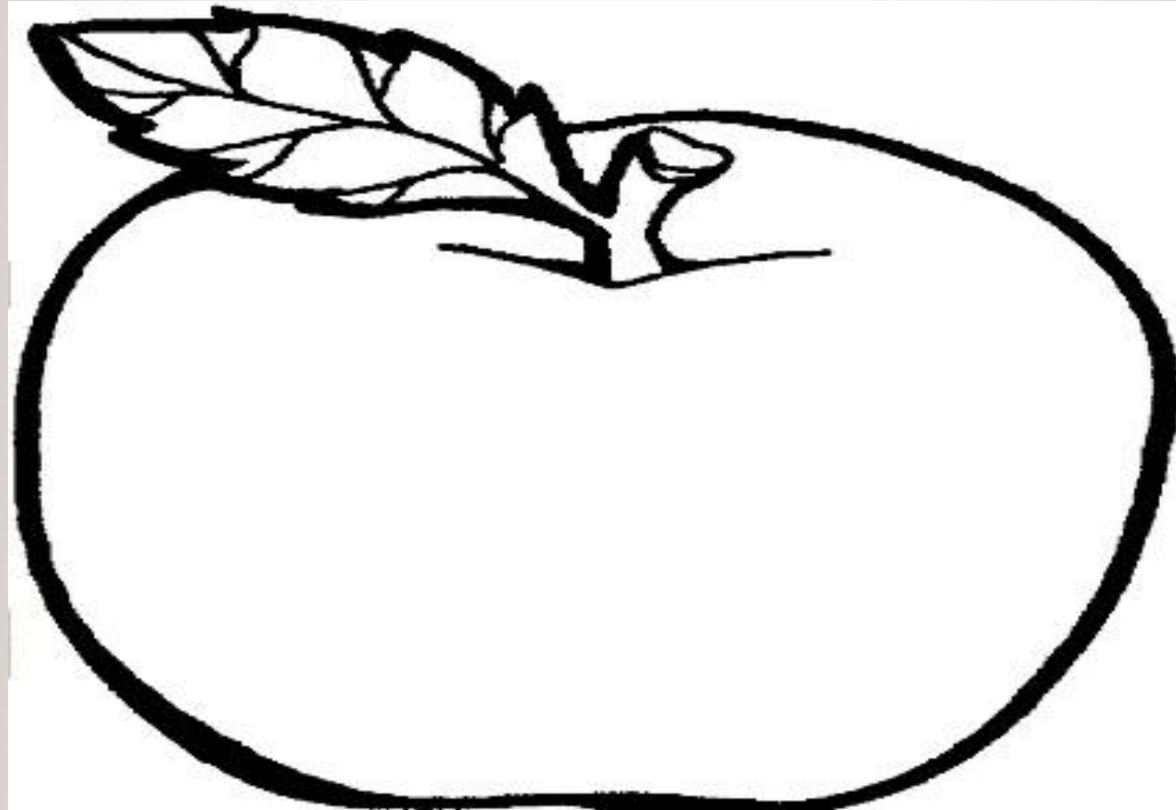
The Pre-Op Speech and Language Evaluation

■ Picture Card Naming

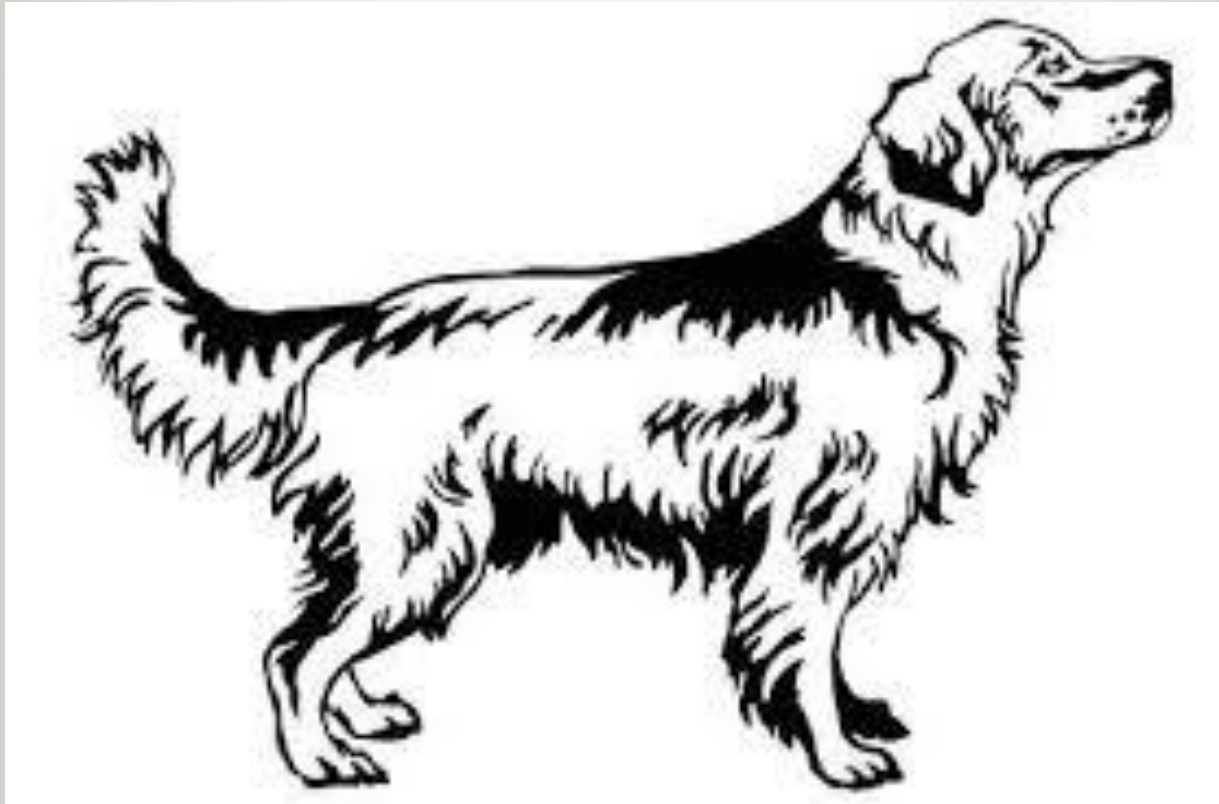
- During intraoperative electrocortical language mapping in the dominant hemisphere, object naming yields more sites of speech interruption than number counting in all cases
- Overlearned speech is not as sensitive in the mapping process but may be appropriate for more complex and/or aphasic patients

- Brennan, N. M. P., Whalen, S., Branco, D. D. M., Oshea, J. P., Norton, I. H., & Golby, A. J. (2007). Object naming is a more sensitive measure of speech localization than number counting: Converging evidence from direct cortical stimulation and fMRI. *NeuroImage*, 37. doi: 10.1016/j.neuroimage.2007.04.052

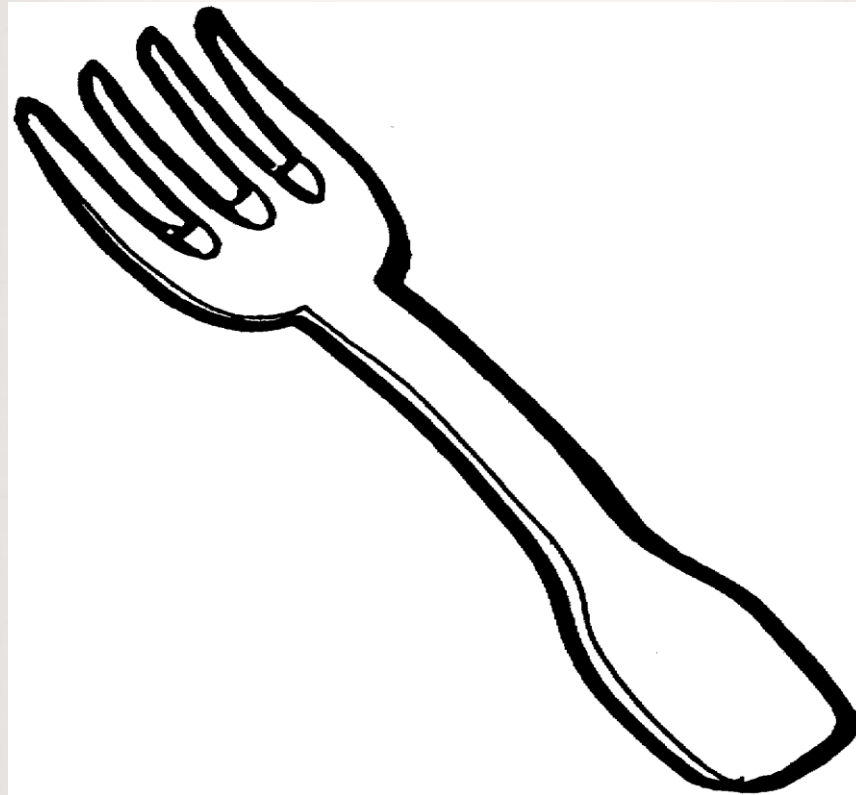
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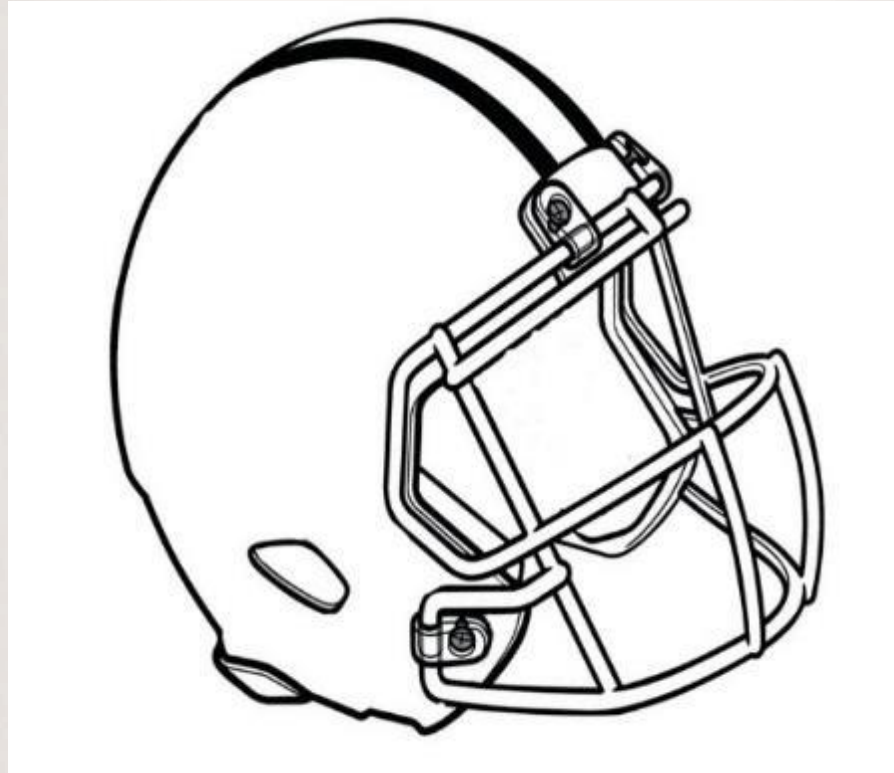
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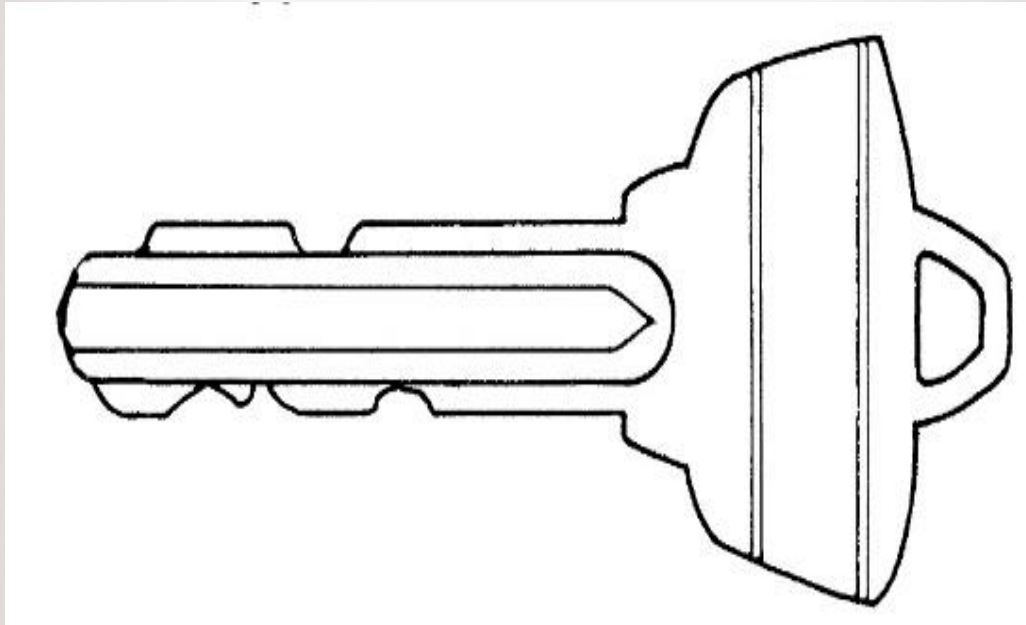
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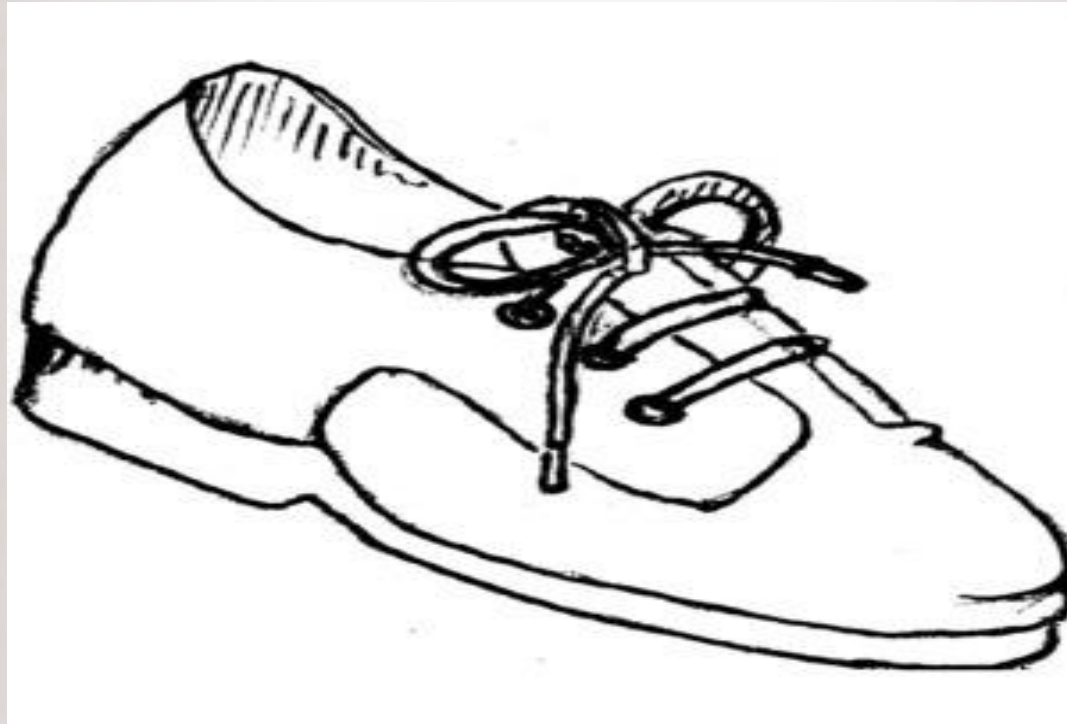
The Pre-Op Speech and Language Evaluation



The Pre-Op Speech and Language Evaluation



The Pre-Op Speech and Language Evaluation



The Pre-Op Speech and Language Evaluation



The Pre-Op Speech and Language Evaluation



The Pre-Op Speech and Language Evaluation

- Picture Card Naming
 - Patient should be able to name most picture cards reliably and consistently
 - Use of a carrier phrase
 - “This is a ...”
 - PRACTICE!

The Pre-Op Speech and Language Evaluation

- Conversation Topic Generation
 - Conversational topics that can be used during during the tumor resection
 - Topics should be personal to the patient to help elicit as much fluent conversational exchange as possible
 - Goal is to keep the patient talking

The Pre-Op Speech and Language Evaluation

■ Conversation Topic Generation

- Work
- Hobbies
- Vacations
- Television
- Books
- Foods
- Entertainment
- Avoid topics that carry a lot of emotion



The Pre-Op Speech and Language Evaluation

- Standardized Language Assessments
 - Boston Naming Test (BNT)
 - Boston Diagnostic Aphasia Examination (BDAE)
 - Cognitive Linguistic Quick Test (CLQT)

The Pre-Op Speech and Language Evaluation

■ Standardized Language Assessments

- Boston Naming Test (BNT)
- Authors: Kaplan, Edith, Goodglass, Harold, Weintraub, Sandra
- “The Boston Naming Test (BNT), consisting of 60 black and white line drawings of objects, is a measure of confrontation naming that takes into account the finding that patients with dysnomia often have greater difficulties with the naming of low frequency objects.”
- normed on 210 cognitively intact adults, ages 18-79

- Roth C. (2011) Boston Naming Test. In: Kreutzer J.S., DeLuca J., Caplan B. (eds) Encyclopedia of Clinical Neuropsychology. Springer, New York, NY



The Pre-Op Speech and Language Evaluation

■ Standardized Language Assessments

- Boston Diagnostic Aphasia Examination (BDAE)
- Authors: Authors: Harold Goodglass, Edith Kaplan, Barbara Barresi
- “The Boston Diagnostic Aphasia Examination (BDAE) is a comprehensive, multiple subtests instrument for investigating a broad range of language impairments that are common consequences of brain damage. It is designed as a comprehensive measure of aphasia. “

- Roth C. (2011) Boston Diagnostic Aphasia Examination. In: Kreutzer J.S., DeLuca J., Caplan B. (eds) Encyclopedia of Clinical Neuropsychology. Springer, New York, NY



The Pre-Op Speech and Language Evaluation

■ Standardized Language Assessments

- Cognitive Linguistic Quick Test (CLQT)
- Author: Nancy Helm-Estabrooks
- Domains:
 - Personal Facts
 - Symbol Cancellation
 - Confrontation Naming
 - Clock Drawing
 - Story Retelling
 - Symbol Trails
 - Generative Naming
 - Design Memory
 - Mazes
 - Design Generation



Candidates

- Retrospective study collecting data on patients undergoing awake craniotomy in Tel Aviv Medical Center between 2003 – 2010. Review of 424 patients.
- Conclusions:
 - need for multi-disciplinary teams
 - stringent patient selection
 - failures can be preventable by meticulous patient selection and avoidance of drugs that might change a patient's cognitive status

Charchaflieh, J., & Park, K. (2013). Faculty of 1000 evaluation for Failed awake craniotomy: a retrospective analysis in 424 patients undergoing craniotomy for brain tumor. *F1000 - Post-Publication Peer Review of the Biomedical Literature*. doi: 10.3410/f.718056144.793481450



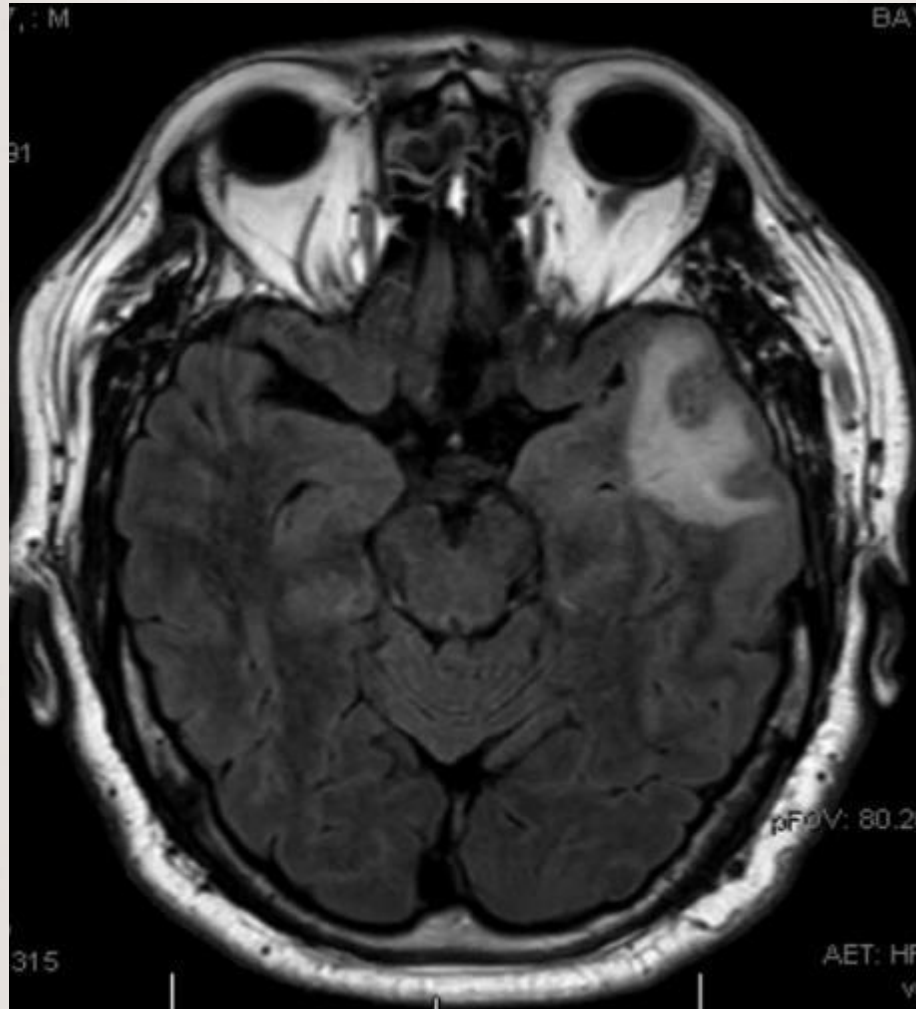
Candidates

- Good Candidate
 - Minimal naming errors
 - Good comprehension
 - Low anxiety
 - Easy conversationalist

Candidates

- Good candidate case study
 - The patient is a 71 year old male
 - One instance of difficulty speaking for 2-3 minutes, but had completely resolved
 - MRI revealed a mass located in the left temporal lobe
 - No complaints of aphasia or dysarthria
 - Patient reported “memory problems”

Candidates



Candidates

- Good candidate case study
 - Patient named 60/60 picture cards
 - Scores WNL on BNT, BDAE, and CLQT
 - Great conversationalist
 - Anxiety very low
 - Joked appropriately with clinician

Candidates

- Good candidate case study
 - Woke easily from anesthesia
 - Named picture cards without trouble
 - Required occasional re-direction
 - Conversed with minimal prompting
 - Continued to joke appropriately

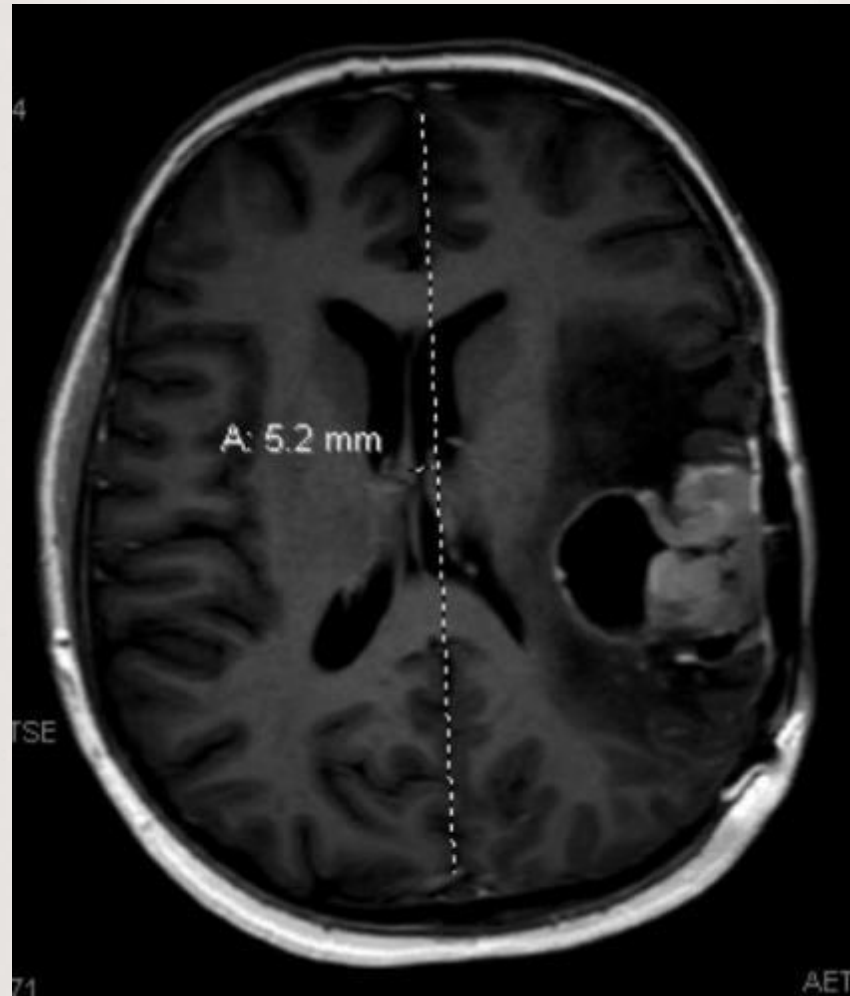
Candidates

- Marginal Candidate
 - Some errors naming
 - Mild-Moderate errors during assessment
 - Anxiety
 - Mild difficulty conversing

Candidates

- Marginal candidate case study
 - 47 year old female
 - MRI showed a multi-cystic left frontotemporoparietal lesion
 - History of debulking surgeries and radiation therapy
 - Patient had worsening dysarthria and aphasia
 - Plan for awake craniotomy

Candidates



Candidates

- Marginal candidate case study
 - Patient verbally fluent, but produced occasional dysfluencies (prolongations, part-word repetitions) during anomias
 - Receptive language skills WNL
 - Patient named 38/60 cards to be used during the awake craniotomy
 - **Patient expressed that she is not a conversationalist, and she had concerns that she would not produce fluid conversation**
 - **Mild anommic aphasia**

Candidates

- Marginal candidate case study
 - Patient had difficulty rousing from anesthesia
 - Patient had difficulty during the awake portion and maintaining conversation
 - Patient often producing one word responses
 - Eventually spoke in sentence length conversation
 - Spoke prayers

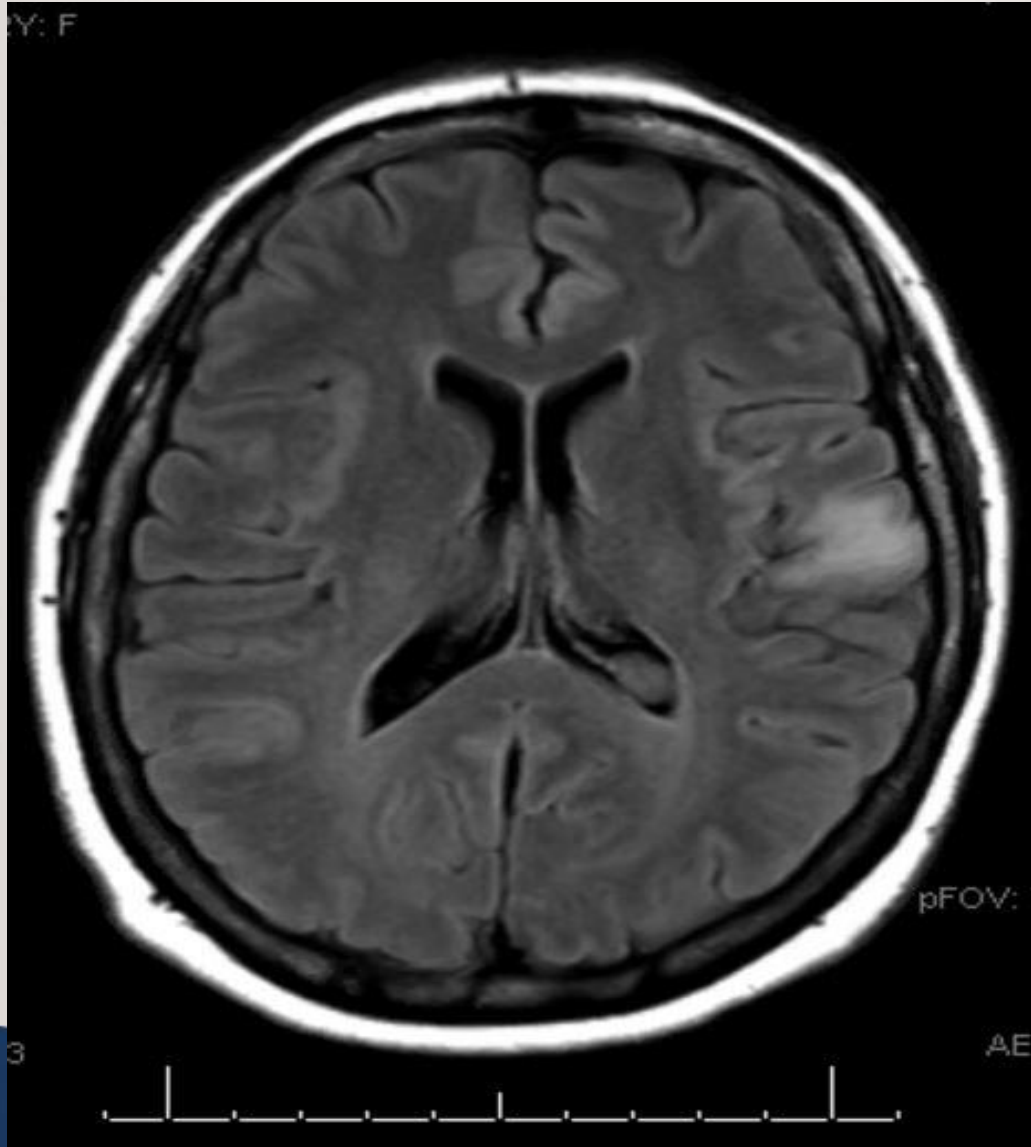
Candidates

- Poor Candidate
 - Several naming errors
 - Poor assessment scores
 - High anxiety
 - Difficult to elicit conversation

Candidates

- Poor candidate case study
 - The patient is a 51 year-old female
 - Left parietal lesion. MRI, “...demonstrate a flair change in the left parietal operculum, likely in the facial motor area.”
 - Neurosurgery discussed with patient that she may not be a candidate for awake craniotomy, but she should meet with Speech Pathology to also discuss candidacy

Candidates



Candidates

- Poor candidate case study
 - Patient scored WNL limits on the standardized assessments
 - However, patient did have some instances of word finding difficulties consistent with a mild anommic aphasia
 - However, clock drawing on CLQT was mildly disrupted but still considered WNL

Candidates

- Poor candidate case study
 - ANXIETY
 - “...becomes extremely nervous and anxious the day of the surgery and has difficulty remaining calm. She recounted one instance in which she woke up in the middle of a procedure and had to be further restrained and sedated”
 - “She had difficulty focusing attention on tasks. At times, patient was very tangential and told stories that were very off topic. Patient reported a history of Attention Deficit Disorder.”

Candidates

- Poor candidate case study
 - SLP communicated concerns to Neurosurgery, and they agreed
 - Plan to follow up with Neurosurgery and repeat MRI in two months
 - MRI did not show change in the lesion
 - Patient adamant about surgery
 - SLP repeated pre-op evaluation; patient clinically similar to initial evaluation
 - Plan was to proceed with surgery

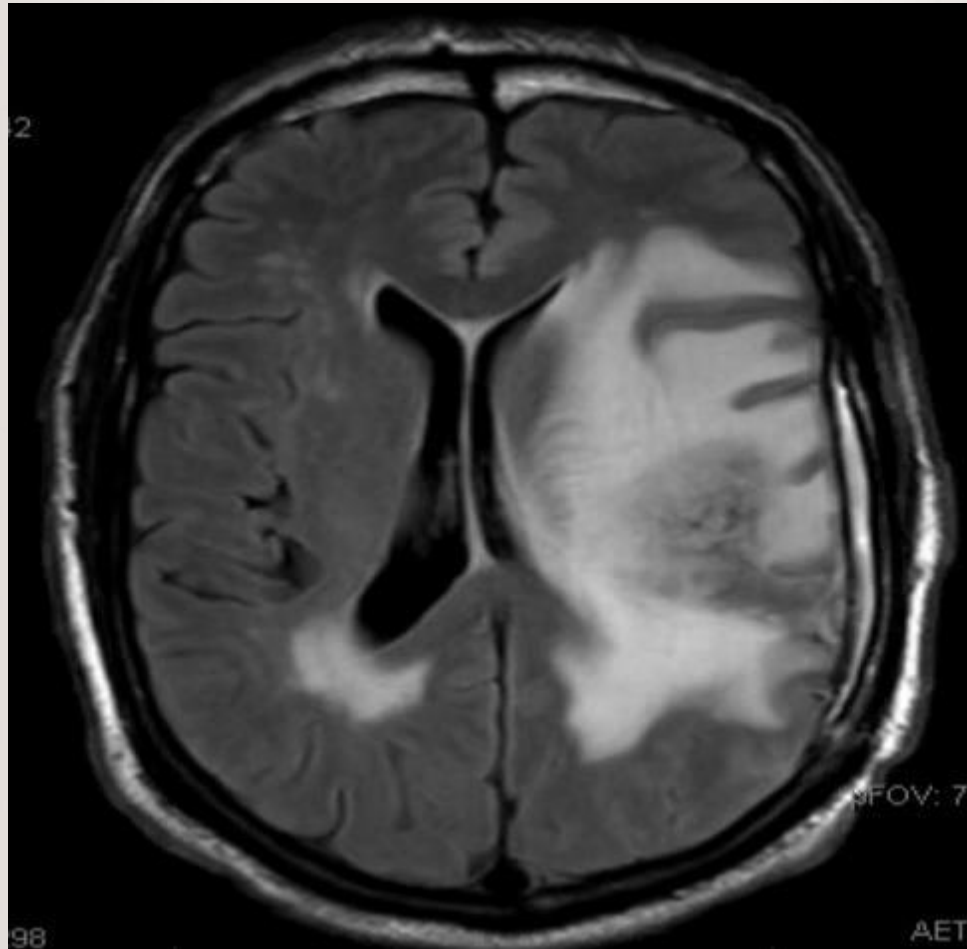
Candidates

- Poor candidate case study
 - SLP called to OR suite
 - Anesthesia was weaned
 - Patient woke and was extremely agitated
 - Screaming
 - Attempting to get off table
 - Could not calm
 - Patient was put back to sleep and awake portion was aborted

Candidates

- Poor candidate case study
 - 66 year old male
 - Left fronto-parietal tumor
 - Awake craniotomy performed in July, 2019
 - He performed well
 - Glioblastoma
 - Worsening aphasia and dysarthria in February, 2020
 - Repeat MRI revealed disease progression
 - Plan for repeat awake craniotomy for further resection

Candidates



Candidates

- Poor candidate case study
 - Patient with a significant non-fluent aphasia most consistent with the transcortical motor type
 - Impaired naming of picture cards
 - Ran through cards numerous times, and he was not reliable
 - Receptive language skills mostly intact
 - Verbal output mostly comprised of single words
 - Frequent halting speech with fillers, hesitations, and anomias

Candidates

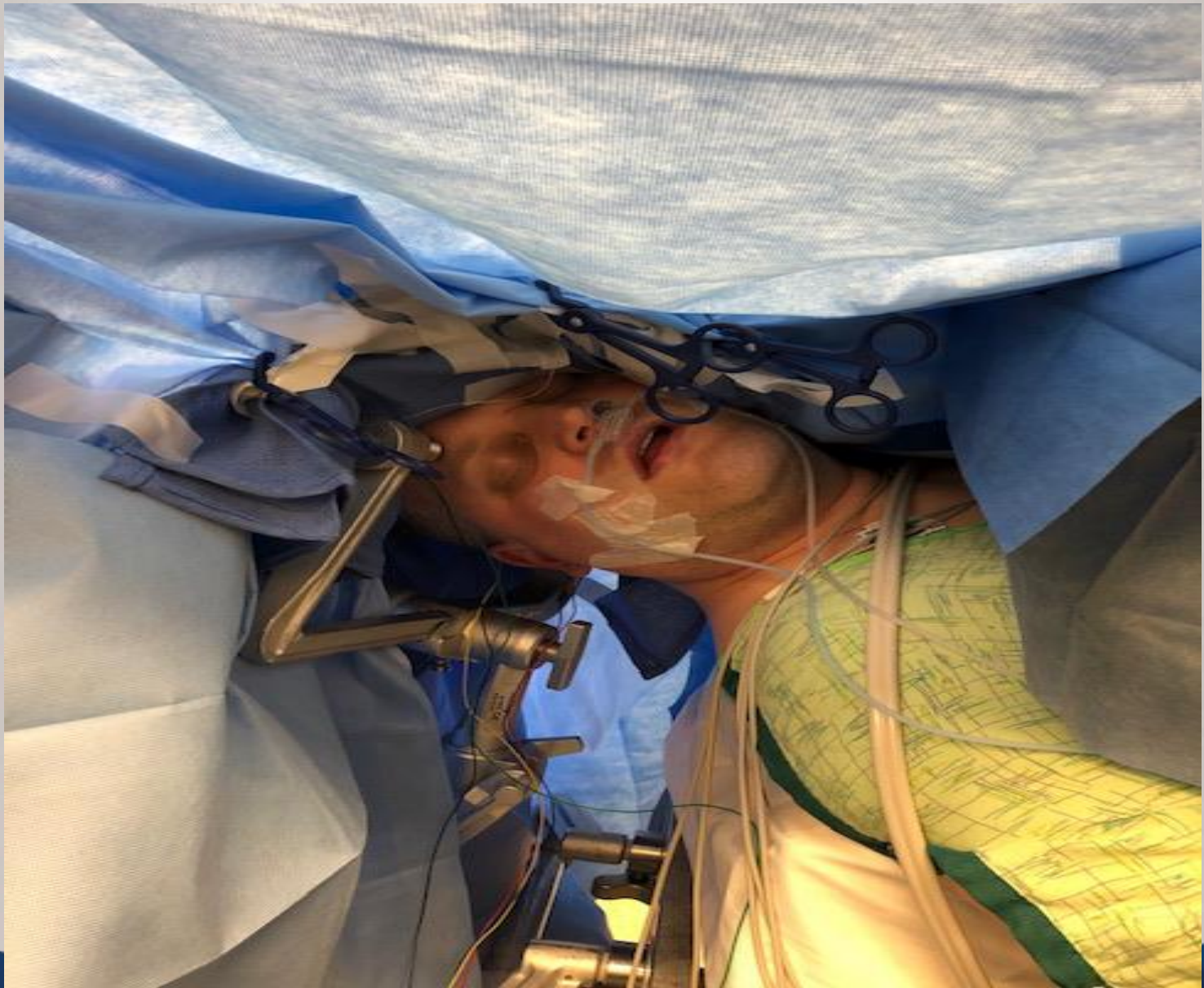
- Poor candidate case study
 - Findings and concerns communicated to Neurosurgery
 - Asleep resection

The Intra-Op Speech and Language Testing

- Portion of skull removed, and brain is exposed
- Anesthesia is weaned, patient begins to rouse, and the SLP is notified
- Arrive to OR with previously tested pictures loaded onto Ipad
 - Printed pictures
- Conversation topics

The Intra-Op Speech and Language Testing

- Decline in language function?
 - Language functions of 79 patients were evaluated and compared 1-2 days before surgery and after entering OR prior to the actual surgery
 - There was a significant decline in language function beyond the sedation effect after entering the OR
 - Tumor grade and the presence of preoperative language deficits were significant risk factors for this phenomenon.
 - Gonen, T., Sela, G., Yanakee, R., Ram, Z., & Grossman, R. (2017). Surgery-Independent Language Function Decline in Patients Undergoing Awake Craniotomy. *World Neurosurgery*, 99, 674–679. doi: 10.1016/j.wneu.2016.12.081



The Intra-Op Speech and Language Testing

- Picture card naming
 - Stimulation
- Fluent conversation
 - Lesion resection

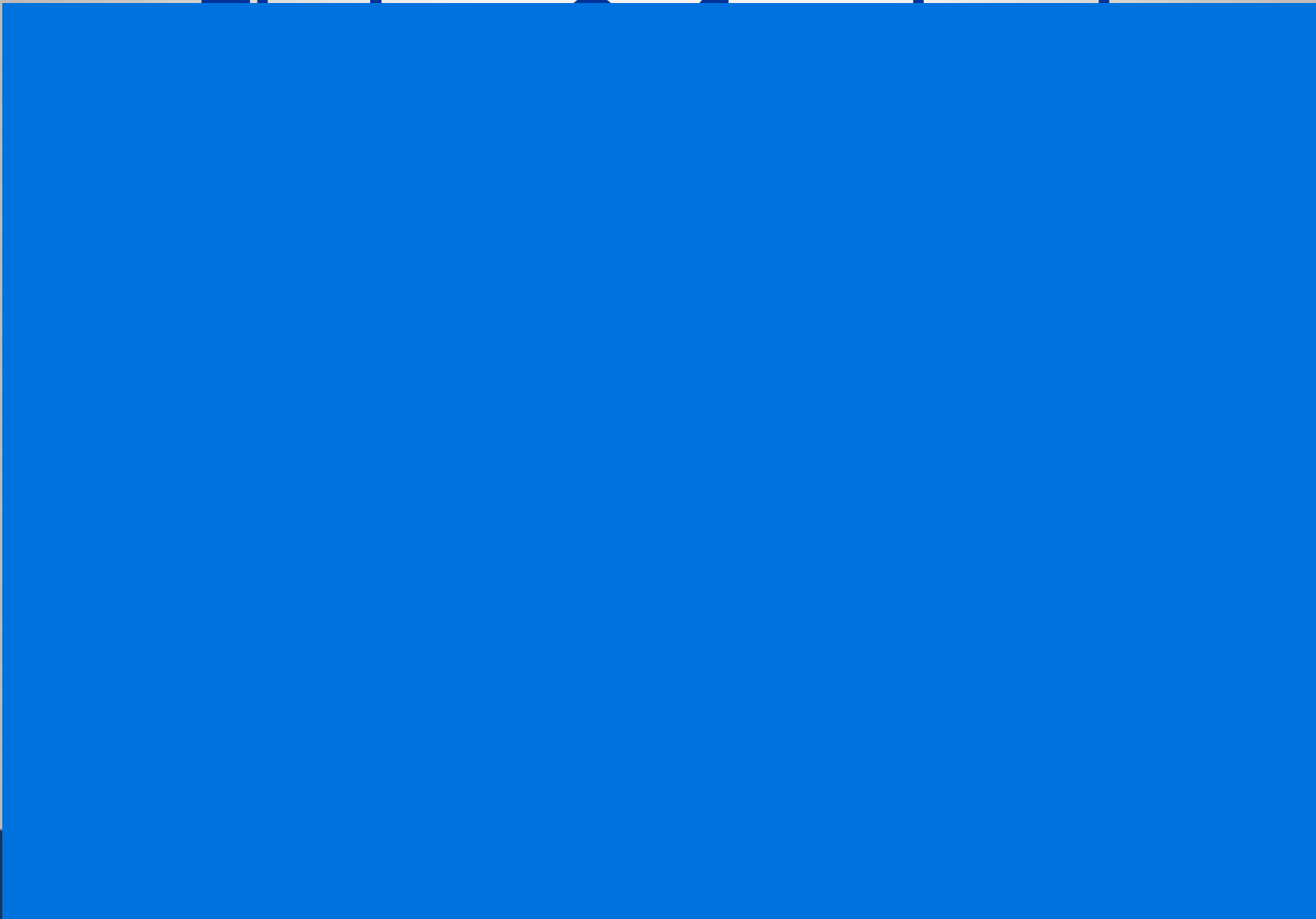
The Intra-Op Speech and Language Testing

- Patient must be alert enough to participate
- Communicate with the surgeon
 - Get a rhythm
- Test run
- Naming with electrical stimulation









The Intra-Op Speech and Language Testing

- What are we monitoring?
 - Picture card naming
 - Language errors
 - Phonemic
 - Semantic
 - Arrests
 - Perseverations

The Intra-Op Speech and Language Testing

- What are we monitoring?
 - Speech
 - Facial weakness
 - Dysarthria
 - Anything out of the ordinary
 - Facial twitching
 - Pain



The Intra-Op Speech and Language Testing

- What does it mean?
 - Errors are ok
 - We are identifying the language center in the brain
 - If errors are elicited during stimulation, this typically relates to the language area
 - Consistency

The Intra-Op Speech and Language Testing

- Lesion resection
 - Conversation
 - Keep the patient engaged and producing fluent speech

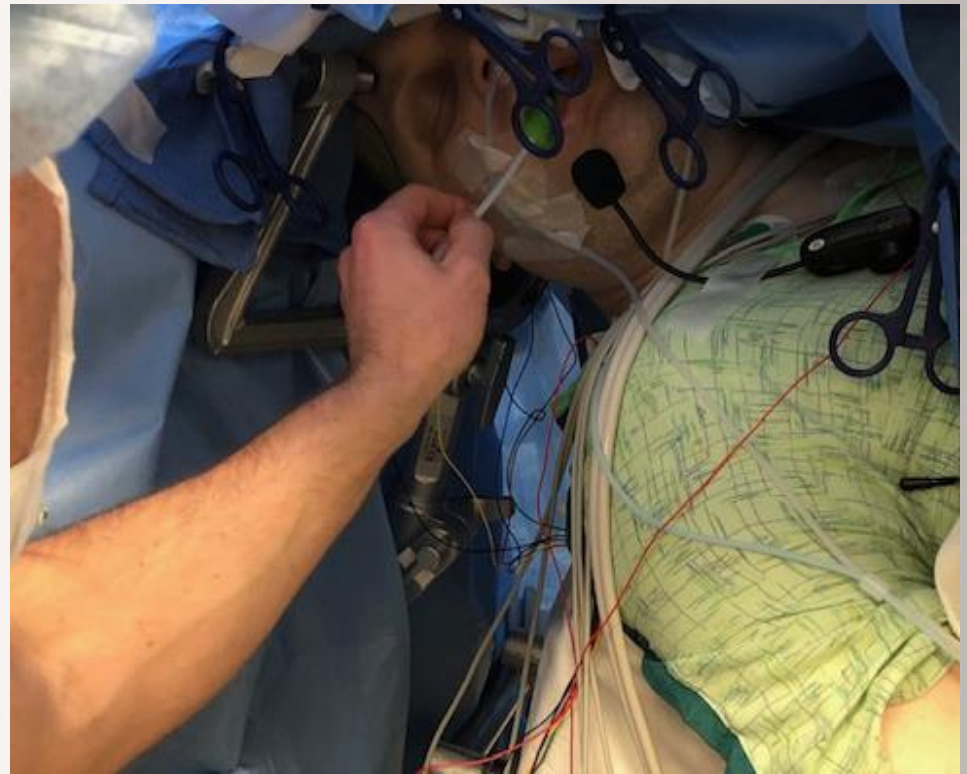


The Intra-Op Speech and Language Testing

- What are we monitoring?
 - Language
 - Both expressive and receptive
 - Paraphasias
 - Responses to questions
 - Speech
 - Dysarthria

The Intra-Op Speech and Language Testing

- Other things to consider
 - Pain
 - Dry mouth
 - Tiredness
 - Vision
 - Other factors affecting speech
 - Anxiety



The Intra-Op Speech and Language Testing

- Retrospective study collecting data on patients undergoing awake craniotomy in Tel Aviv Medical Center between 2003 – 2010. Review of 424 patients.
 - A failed awake craniotomy was defined as conversion to general anesthesia or cortical mapping or monitoring were either aborted prematurely or not performed successfully.
 - Failed awake craniotomy was encountered in 27 patients.
 - In 9 patients, reversion to general anesthesia required due to seizures, **severe restlessness**, or acute brain edema
 - In 18 patients, failure was a result of problems with intraoperative cortical mapping/ monitoring due to **severe dysphasia/aphasia, restlessness, or somnolence**

■ Charchaflieh, J., & Park, K. (2013). Faculty of 1000 evaluation for Failed awake craniotomy: a retrospective analysis in 424 patients undergoing craniotomy for brain tumor. *F1000 - Post-Publication Peer Review of the Biomedical Literature*. doi: 10.3410/f.718056144.793481450



Post Op

- Typically follow up 1-2 days following surgery
- What do we encounter?
 - Similar speech/language skills compared to pre-op
 - Worsened aphasia
 - Edema
 - Time
 - steroids

Post Op

- Study involved 46 cases of awake craniotomy.
 - 17 of the 46 observed to have neurological deterioration in the intraoperative period.
 - All patients had a return to baseline language skills prior to surgery at 1 month follow up.

Akay, A., & Islekel, S. (2017). Awake craniotomy procedure: its effects on neurological morbidity and recommendations. *Turkish Neurosurgery*. doi: 10.5137/1019-5149.jtn.19391-16.1

Post Op

- Patients who underwent awake craniotomy were administered a questionnaire post-op
 - 20% of patients had no recollection of actually being awake and tested
 - Seven patients described comfortable conditions, four expressed mild discomfort, and three expressed considerable discomfort. This was due to the head clamp being too tight and lying on their limbs
 - Nine expressed no fear during procedure, three a little fear, and two said they were very afraid
 - Findings of this study are significant for discomfort and pain in 20%, anxiety in 29%, and fear in 14%
- Whittle, I. R., Midgley, S., Georges, H., Pringle, A.-M., & Taylor, R. (2005). Patient perceptions of “awake” brain tumour surgery. *Acta Neurochirurgica*, 147(3), 275–277. doi: 10.1007/s00701-004-0445-7

Conclusions

- Multi-disciplinary teams are important
- The Speech Language Pathologist plays a critical role in all aspects of the awake craniotomy
- Know as much as you can about the patient
- Not everyone is a candidate for an awake craniotomy
- Know what to expect in the OR
- Patient may have temporary difficulty post-op

Questions?

