Neuroimaging for the Speech-Language Pathologist

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GEORGETOWN UNIVERSITY SCHOOL OF MEDICINE

COGNITIVE RECOVERY LAB

MedStar National Rehabilitation Hospital

Disclosures

- Employed by Georgetown University
- Affiliated with MedStar National Rehabilitation Network
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Goals and Plan for this Talk

- Understand the differences between neuroimaging modalities and the clinical indications for each type
- Learn some basics of how to look at brain images and what to look for

Me

- Cognitive/Behavioral Neurologist
- In practice for 10 years
- Run a clinic for people with aphasia at NRH twice per month
- Direct the Cognitive Recovery Lab at Georgetown University and NRH

Lab Family

Our mission is to improve the lives of people with cognitive and language difficulties by expanding our understanding of:

1. how the brain performs language and cognitive functions,
2. how these brain systems change in the face of injury or dysfunction, and
3. how we can improve recovery

Lab includes

- Research speech pathologists
- Post-doctoral fellows
- PhD students
- MD/PhD students
- Undergraduate students

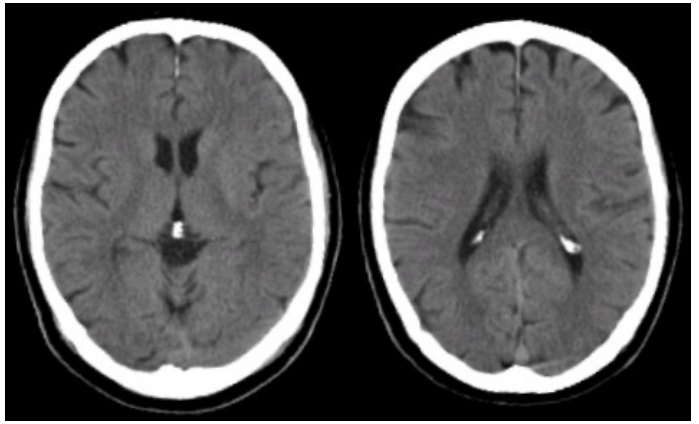
Neuroimaging Modalities

- Computed tomography (CT)
- Computed tomography angiography (CTA)
- Magnetic resonance imaging (MRI)
- Magnetic resonance angiography (MRA)

- Conventional angiography
- Positron Emission Tomography (PET)
- Electroencephalogram (EEG)

Computed Tomography (CT)

- Uses x-rays collected from around the body to create 3D images
- Clinical indications: a very quick (1 minute) scan to find acute hemorrhages or major issues in the brain (e.g., hydrocephalus, herniation)
  - Not very sensitive to hyperacute ischemic strokes or any small stroke
- Tissue Colors:
  - CSF: black
  - White matter: dark grey
  - Cortex: light grey
  - Blood: bright

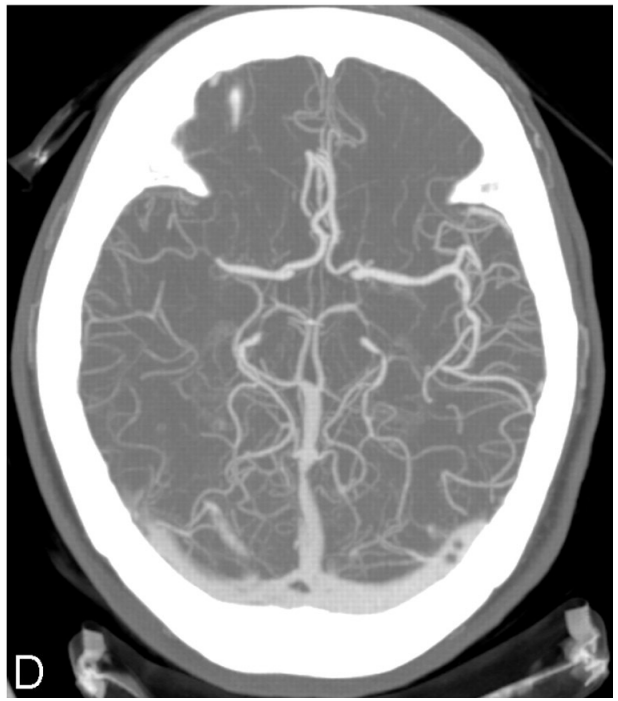


Case.edu

- Contrast is used to see blood vessels, tumors, or inflammation (MS flare, encephalitis, etc. when MRI is not feasible)

Computed Tomography Angiography (CTA)

- Uses IV contrast during a CT to evaluate blood vessels
  - Used during acute ischemic stroke to determine interventions such as tPA or thrombectomy
  - Sometimes gives a clearer picture of vessels than MRA
  - If acute treatment planning is not necessary or the patient cannot get IV contrast due to allergies or renal issues, an MRA might be ordered instead



Yang et al., 2008

Magnetic Resonance Imaging (MRI)

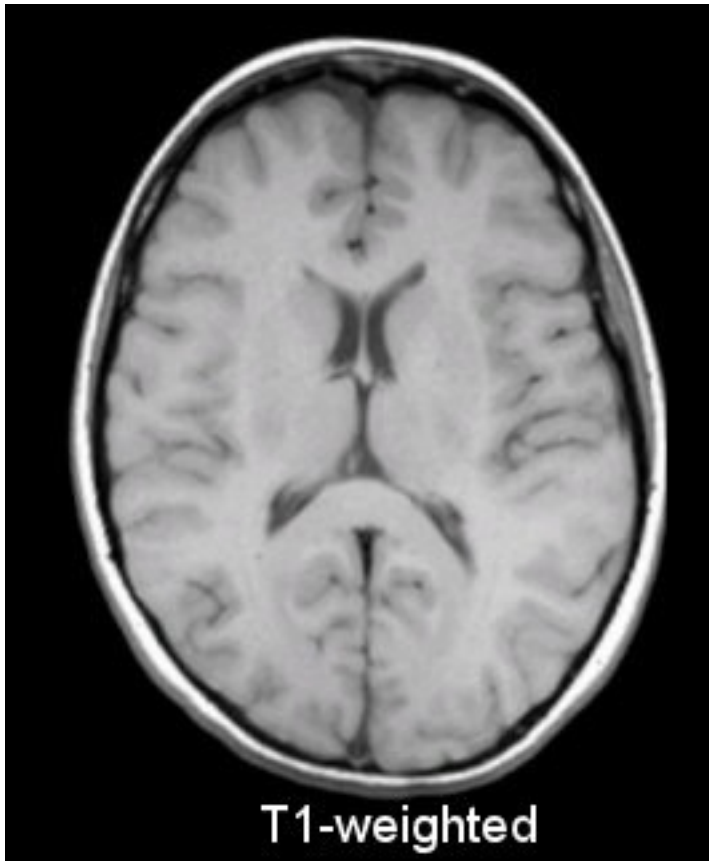
- Uses a magnetic field and radio frequency energy to generate detailed images
- Different types of MRI scans are use for different purposes
- Clinical Indications:
  - Any time you want a detailed picture and don't need it super fast
    - Ischemic stroke
    - Brain atrophy (neurodegeneration)
    - Older damage to white matter ("chronic small vessel ischemic disease")
    - To assess the brain stem or cerebellum (difficult to see on CT)
    - Old bleeds
    - TBI
    - MS
- IV Contrast is used to detect tumors, inflammation (e.g., MS), or infections, such as abscess, meningitis, encephalitis, etc.

Main Types of MRI Scans

- T1-Weighted
- T2-Weighted
- Fluid-Attenuated Inversion Recovery (FLAIR)
- Diffusion-Weighted (DWI)
- Gradient Echo (GRE) or Susceptibility-Weighted (SWI)

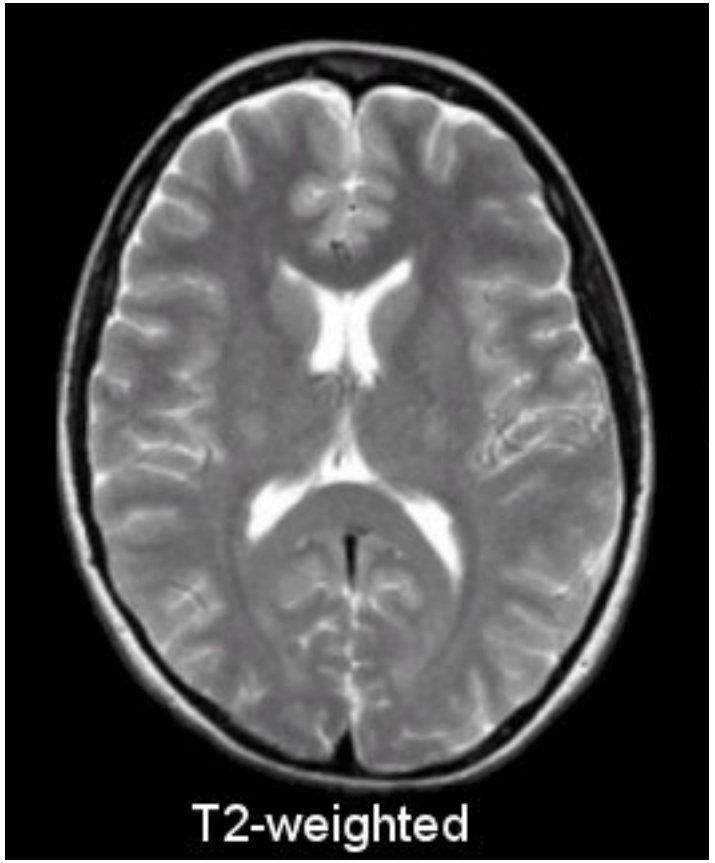
T1-Weighted MRI

- Standard anatomical scan
- Good to assess structure and atrophy
- Used with contrast to detect inflammation or tumors
- Tissue colors:
  - CSF: dark
  - White matter: light grey
  - Cortex: darker grey
  - Damage: usually dark (but sometimes bright)
  - Contrast: bright



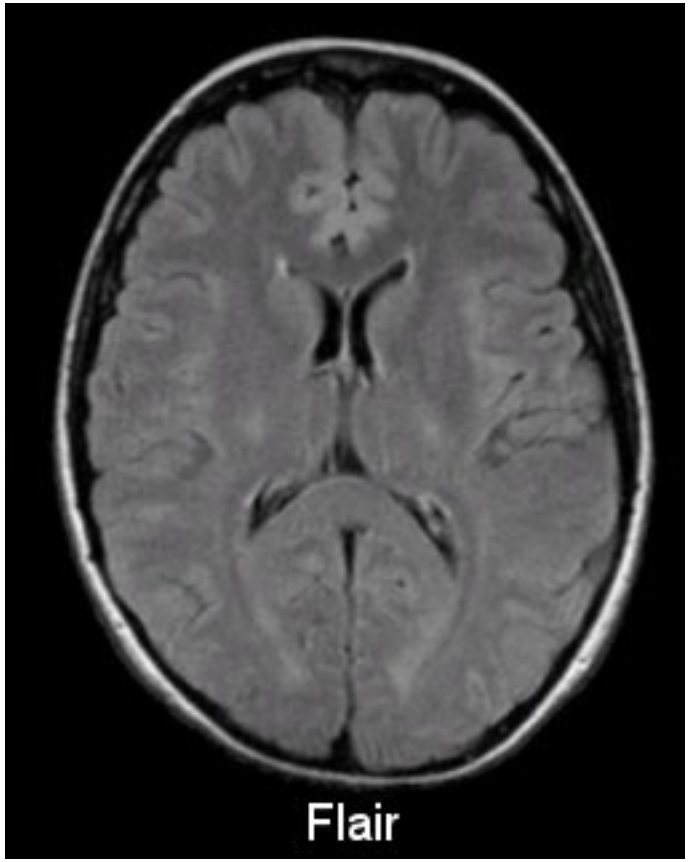
T2-Weighted MRI

- Good for assessing white matter damage, including inflammation and scarring
- Better for assessing the brainstem than FLAIR imaging
- Tissue colors:
  - CSF: bright
  - White matter: dark grey
  - Cortex: light grey
  - Damage: bright



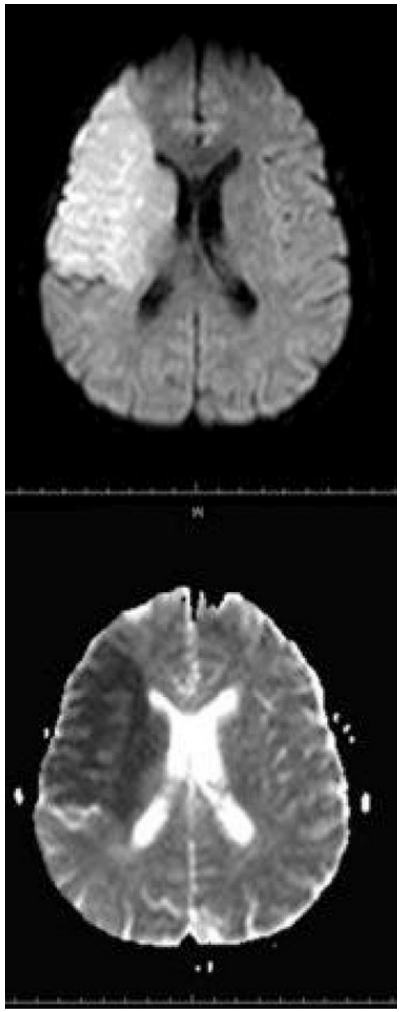
Fluid-Attenuated Inversion Recovery MRI (FLAIR)

- Also good for assessing white matter damage in particular
- FLAIR is like T2 but fluid is dark
  - The ventricles are dark, making it easier to see damage around them, such as MS lesions
  - Contrast in white matter is usually better than T2
- Tissue colors:
  - CSF: dark
  - White matter: dark grey
  - Cortex: light grey
  - Damage: usually bright



Diffusion-Weighted MRI (DWI)

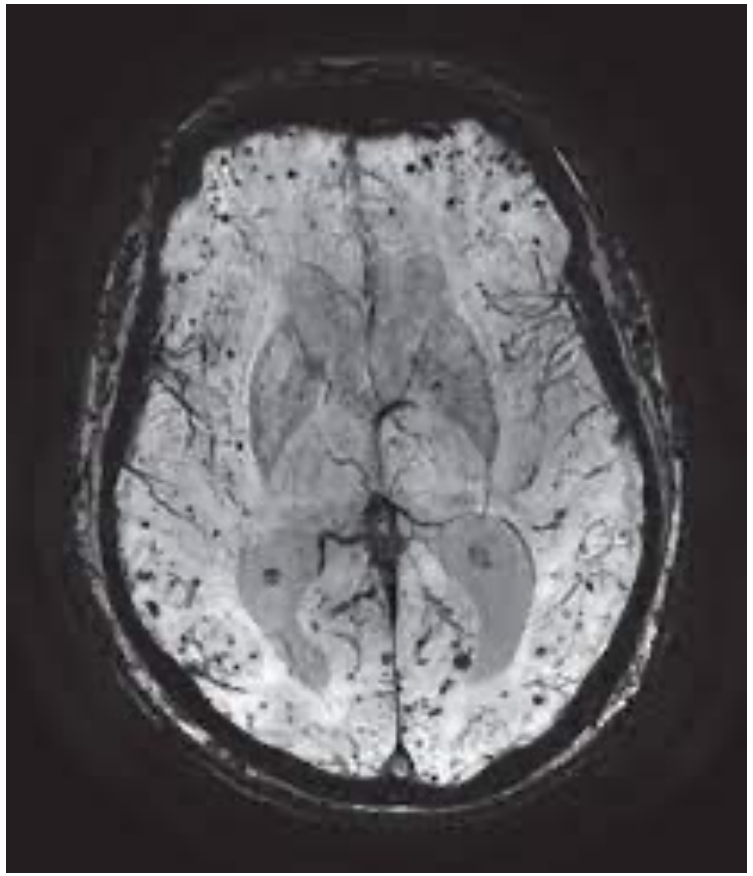
- Primarily used to detect acute ischemic stroke
- Tissue colors:
  - CSF: black
  - White matter: darker grey
  - Cortex: lighter grey
  - Ischemic Stroke: bright (immediately, lasting about 7 days)
- This scan also generates an ADC image, in which the stroke looks dark



Güzel et a., 2016

Gradient Echo (GRE) or Susceptibility Weighted (SWI) MRI

- Used to detect bleeding that occurred at any time in a person's life (iron deposits)
- A common finding is microhemorrhages, which are associated with hypertension or cerebral amyloid angiopathy (frequently associated with Alzheimer's Disease)
- Blood shows up as dark spots



Scheltens and Goos, 2012

Magnetic Resonance Angiography (MRA)

- MRI used to assess blood vessels
- Can be done without contrast
- Picture can sometimes be less clear than a CTA (if the patient doesn't stay still)

Wikipedia.com

MRI Changes Over Time in ischemic stroke

- Acute stroke
  - lights up on DWI immediately, stays lit up for 1-2 weeks
  - CT often shows very little early on, even with large strokes
  - FLAIR/T2 becomes abnormal after several hours to a day
  - Brain swelling peaks about 4-5 days after stroke, resolves after ~2 weeks
- Sub-acute stroke
  - DWI brightness diminishes
  - FLAIR and T1 signal is abnormal
  - Larger strokes visible on head CT
- Chronic stroke
  - Encephalomalacia– fluid filled spaces left after immune system removes dead brain tissue
  - Dark on T1, dark on FLAIR, bright on T2

Let’s look at scans!

Bonus Slides!

Some terminology

- Hyper/hypodensity = bright/dark spots on CT scans (dense things are brighter and less dense things are darker)
- Hyper/hypointensity = bright/dark spots on MRI scans
- Diffusion restriction = bright spots on DWI scans– almost always means an acute ischemic stroke
- Contrast enhancement = structures that look brighter with contrast than without (usually means increased blood vessels (e.g., tumor) inflammation (e.g., MS flare, meningitis, acute stroke after a day or two)

Other Neuroimaging Modalities

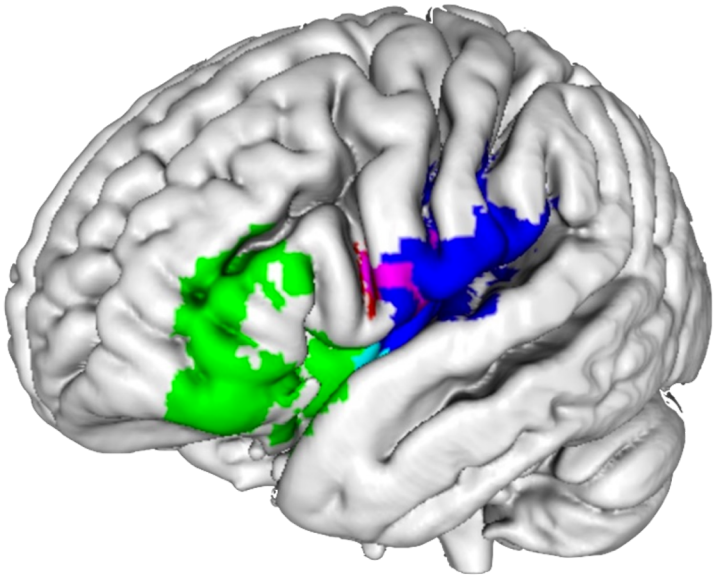
- Positron Emission Tomography (PET)
  - Looking for hyper- or hypo- metabolic activity
  - Often done when looking for brain tumors
  - Used to differentially diagnose AD from frontotemporal dementia
- Electroencephalogram (EEG)
  - Used to diagnose seizure or propensity for seizure
  - “slowing” on EEG is a vague indication that something is wrong
- Conventional (catheter) angiography
  - Used to either plan intervention (i.e., stent, thrombectomy) or for diagnostic purposes when a CTA or MRA is inconclusive (e.g., vasculitis)

Our Research

BUILD: **B**rain-Based **U**nderstanding of **I**ndividual **L**anguage **D**ifferences after Stroke

Our Questions:

- Why is each person different after a stroke?
- What factors impact recovery?
  - How the brain was organized before the stroke
  - Treatment at the hospital
  - Therapy history
  - Family and social support
  - Location and size of the stroke
  - Education



BUILD

- We’re recruiting patients with left hemisphere strokes with or without aphasia or right hemisphere strokes with aphasia
- Benefits of participating:
  - Paid $50/session
  - Get report with cognitive and language testing scores and brain images
  - Can participate in an optional report meeting with Dr. Turkeltaub and the research SLP to review results
  - Get personalized recommendations and referrals to community resources/groups as needed
  - Get a cool brain t-shirt

Thank You!

Georgetown University,
Cognitive Recovery Lab

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