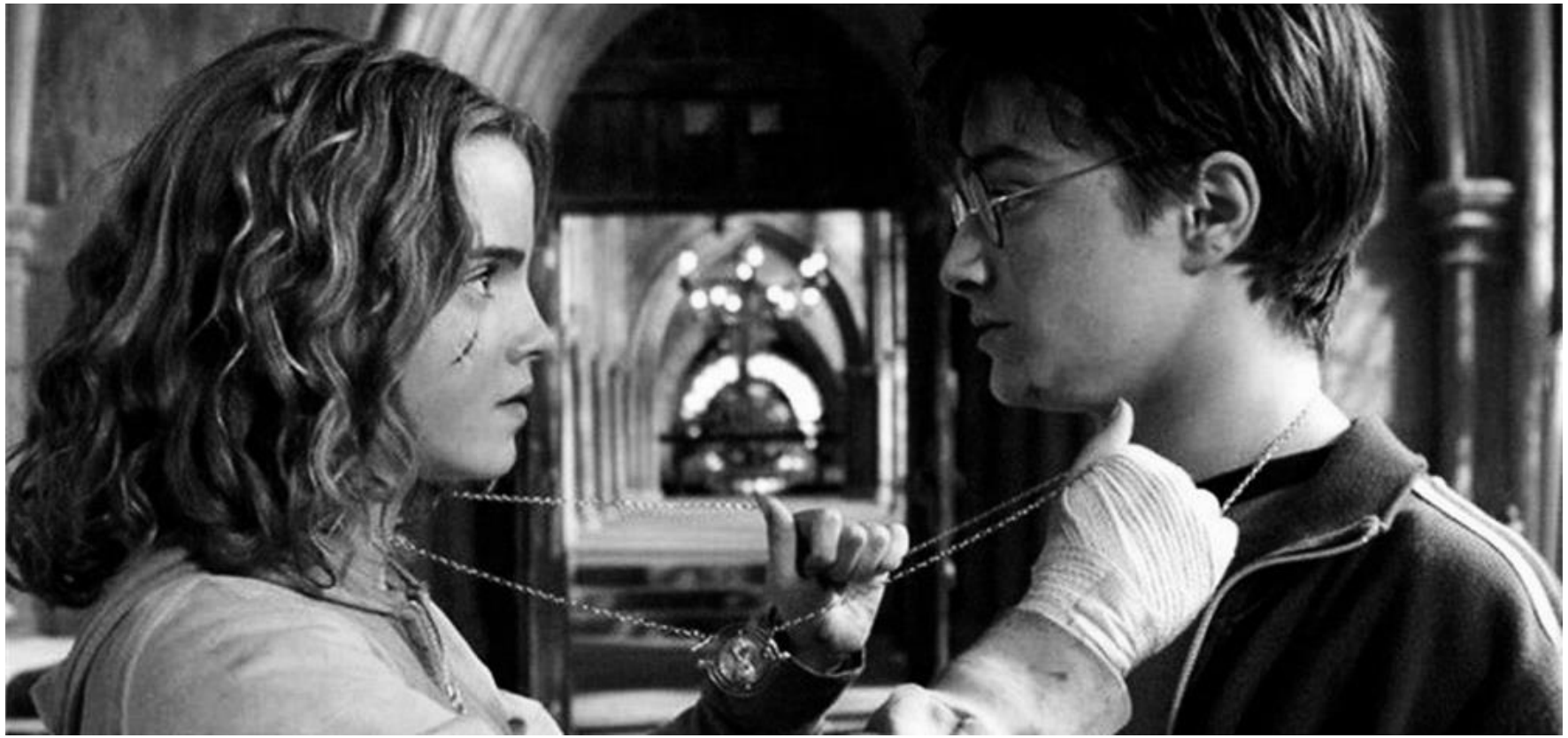
Case of Time Travel



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SUPERVISOR: DR. ADLER

Outline

1. Case
2. Investigation - literature review
3. Discussion

56 year old Caucasian female with reported bipolar disorder, three ischemic strokes, chronic migraines, chronic pain, HTN, dyslipidemia, and breast cancer s/p lumpectomy and tamoxifen in 2007.

Admitted to **acute rehab** 8/24/2016 after recent stroke in July.

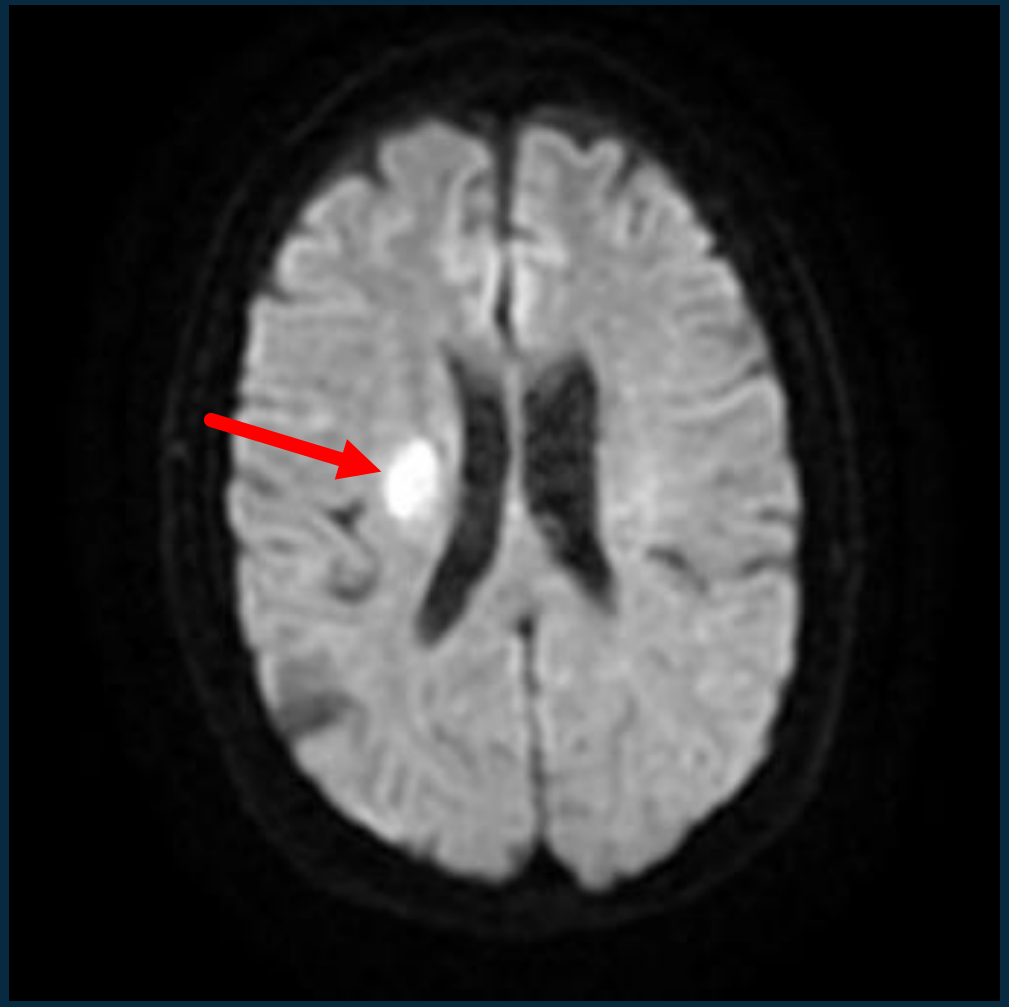
Psychiatry consulted for new onset **hallucinations**.

- 7/29/2016
  - woke up with new L jaw pain, L facial droop, later left arm weakness
  - head CT negative, CTA negative.
  - not IV tPA candidate on anticoagulation, time of onset unknown.
  - sx improved in ED
  - D/C home with outpatient neurology follow up

- Early August follow up with neurology:
  - some residual symptoms
  - impacting ADLs
  - acute rehab recommended
- Admitted to acute rehab on 8/24

MRI in August 2016

acute infarct – R lentiform, R caudate, adjacent corona radiata, small part of internal capsule



- “Hallucinations” for 1 month beginning after stroke in July
  - passenger in car
  - holding her grandson
  - Bathroom

- Component of **time distortion** in each experience
  - “time loops”
  - “time doesn’t proceed linearly for me”
  - “continually if I’m tired”

- Psych review of systems
- Current psych meds
  - Desvenlafaxine
  - Abilify
  - Ambien as needed
- Seeing psychiatrist since 2009
- Bipolar type II or "bipolar spectrum"
- **No acute psych history**
  - No suicidal ideation or attempts
  - No psychiatric hospitalizations
  - No psychotic symptoms
- Unremarkable social history

Mental Status Exam

APPEARANCE/BEHAVIOR: friendly Caucasian female, appropriate eye contact, engaged, polite

SPEECH: mildly decreased rate, normal rhythm/prosody

MOOD: "the time loops have been the most concerning"

AFFECT: euthymic, appropriate, tearful for brief moment

THOUGHT PROCESS: linear, goal-oriented, coherent, interview directed

Mental Status Exam

THOUGHT CONTENT: no SI/HI/AH, +VH, not internally preoccupied

COGNITION: alert, O x 3, attentive to interview

Memory: grossly intact, able to recall names of providers on second visit

MOTOR: no abnormalities

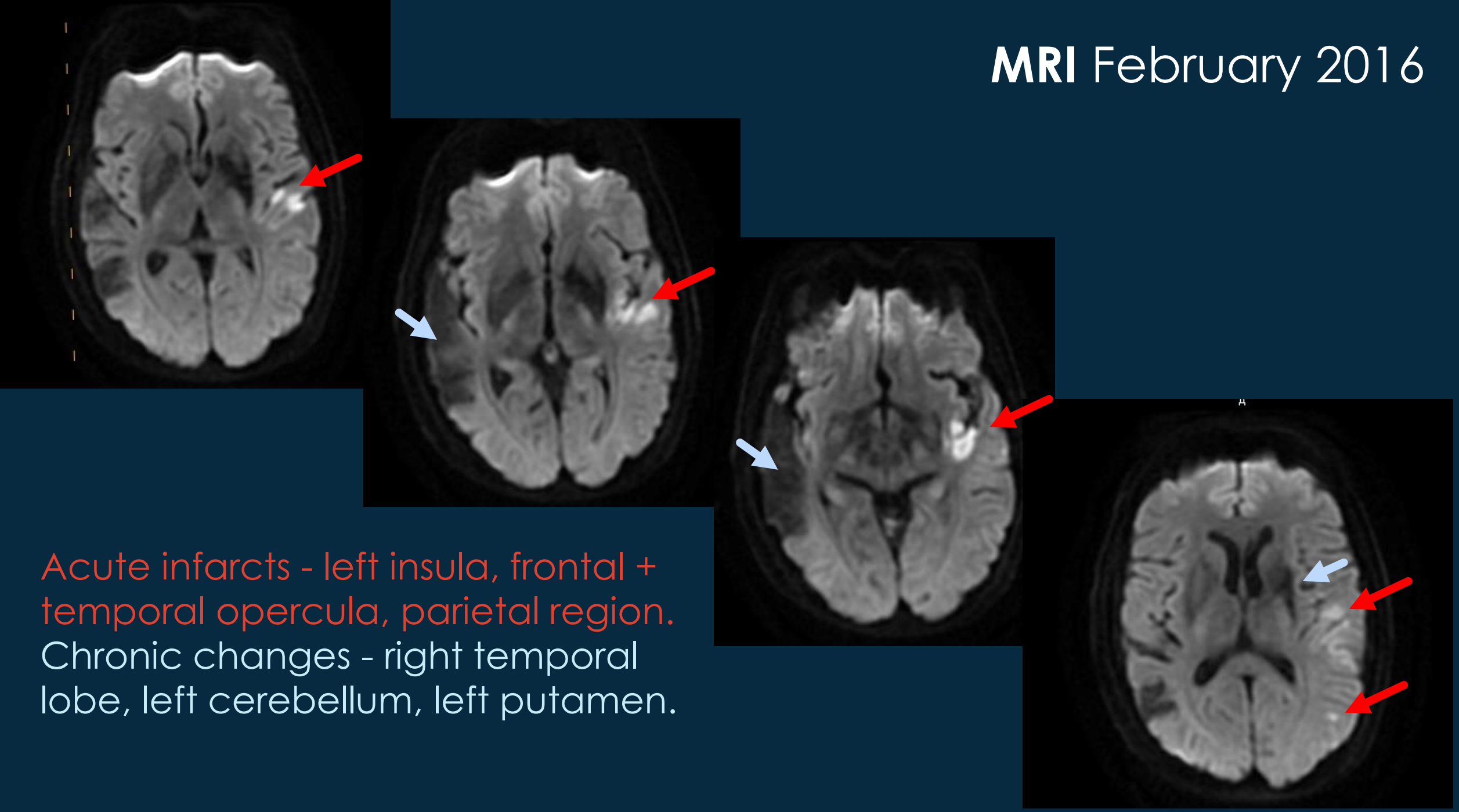
INSIGHT/JUDGMENT: good

Other work up

- Continuous **EEG**
- **PET** scan

INVESTIGATION

MRI February 2016



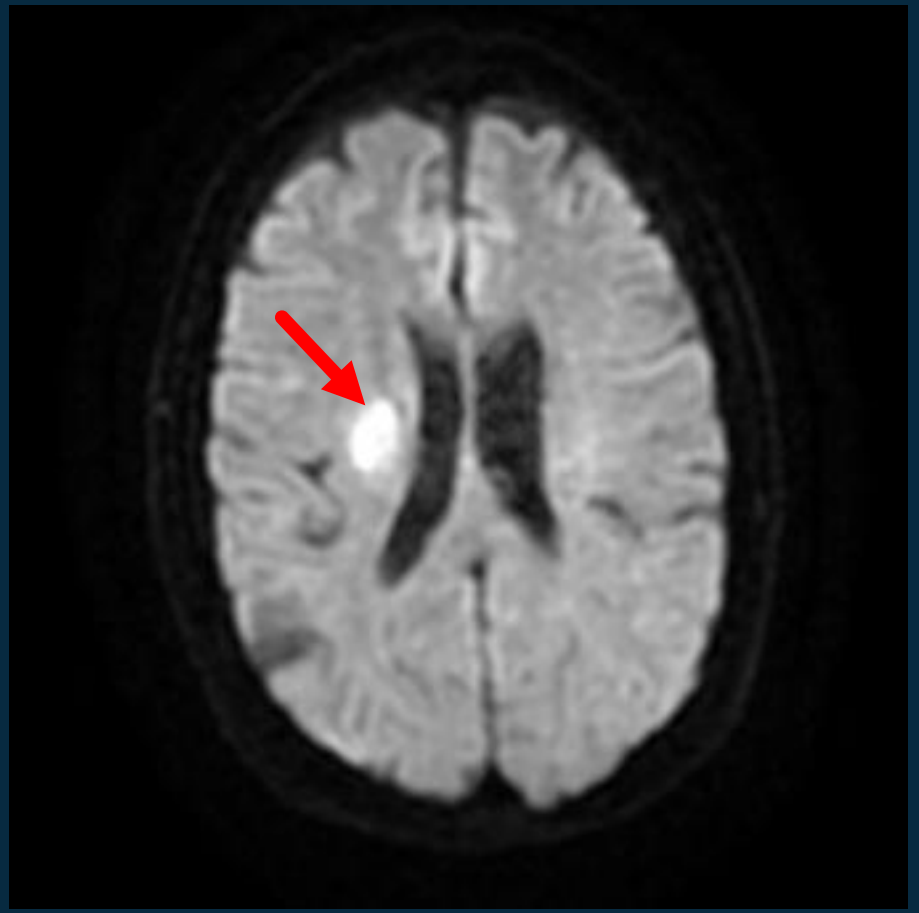
Acute infarcts - left insula, frontal + temporal opercula, parietal region.
Chronic changes - right temporal lobe, left cerebellum, left putamen.

MRI August 2016

R lentiform nucleus, R caudate and adjacent corona radiata, small part of internal capsule

Right lentiform:
muscle tone, precision movement, muscle memory

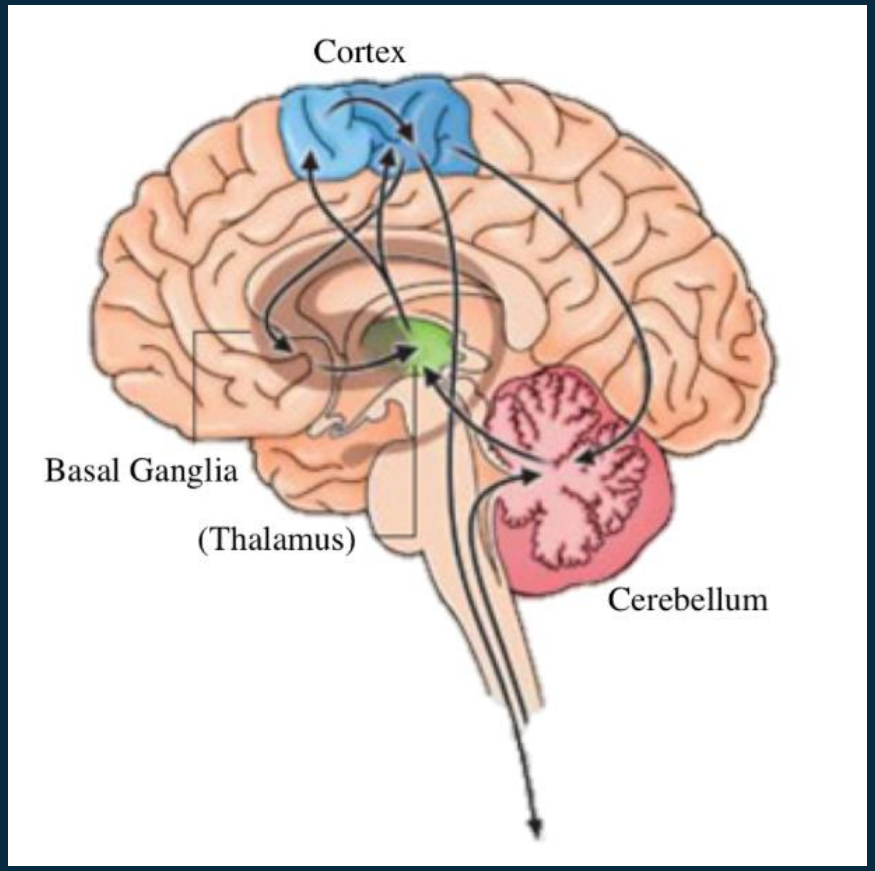
Right caudate:
store/process memory, using info from past experiences to influence future actions/decisions, particularly use of language, implication in OCD*



* Giedd et al. 2000

Physiology of Time Perception

- Integration of neural systems
- Hypothesized to rely on DA in corticostriatal circuits, modulated by serotonin and glutamate activity
- Involving cerebellum, frontal cortex, hippocampus, basal ganglia
- Scalar expectancy (timing) theory
- Striatal beat frequency model



Allman & Meck, 2012. Pathophysiological distortions in time perception and timed performance. *Brain,* 135: 656-677

Scalar Expectancy (Timing) Theory

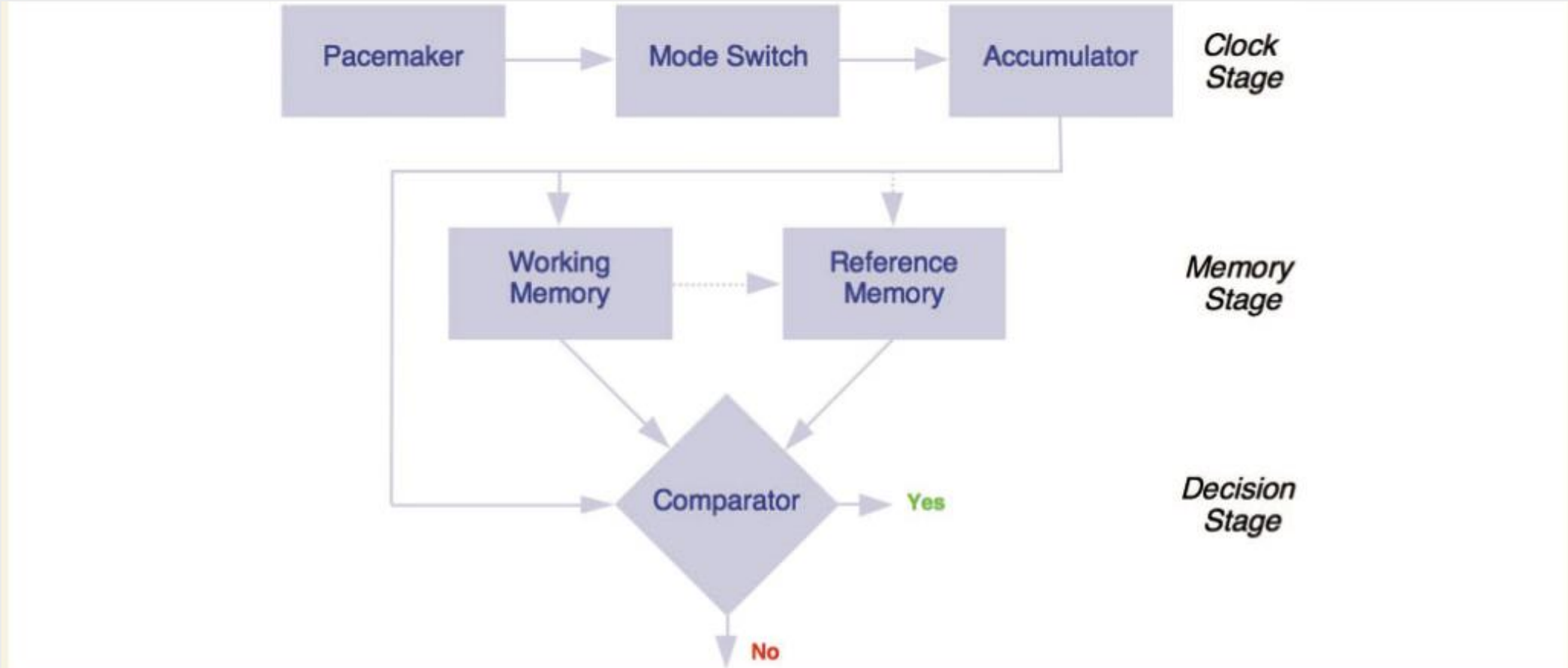
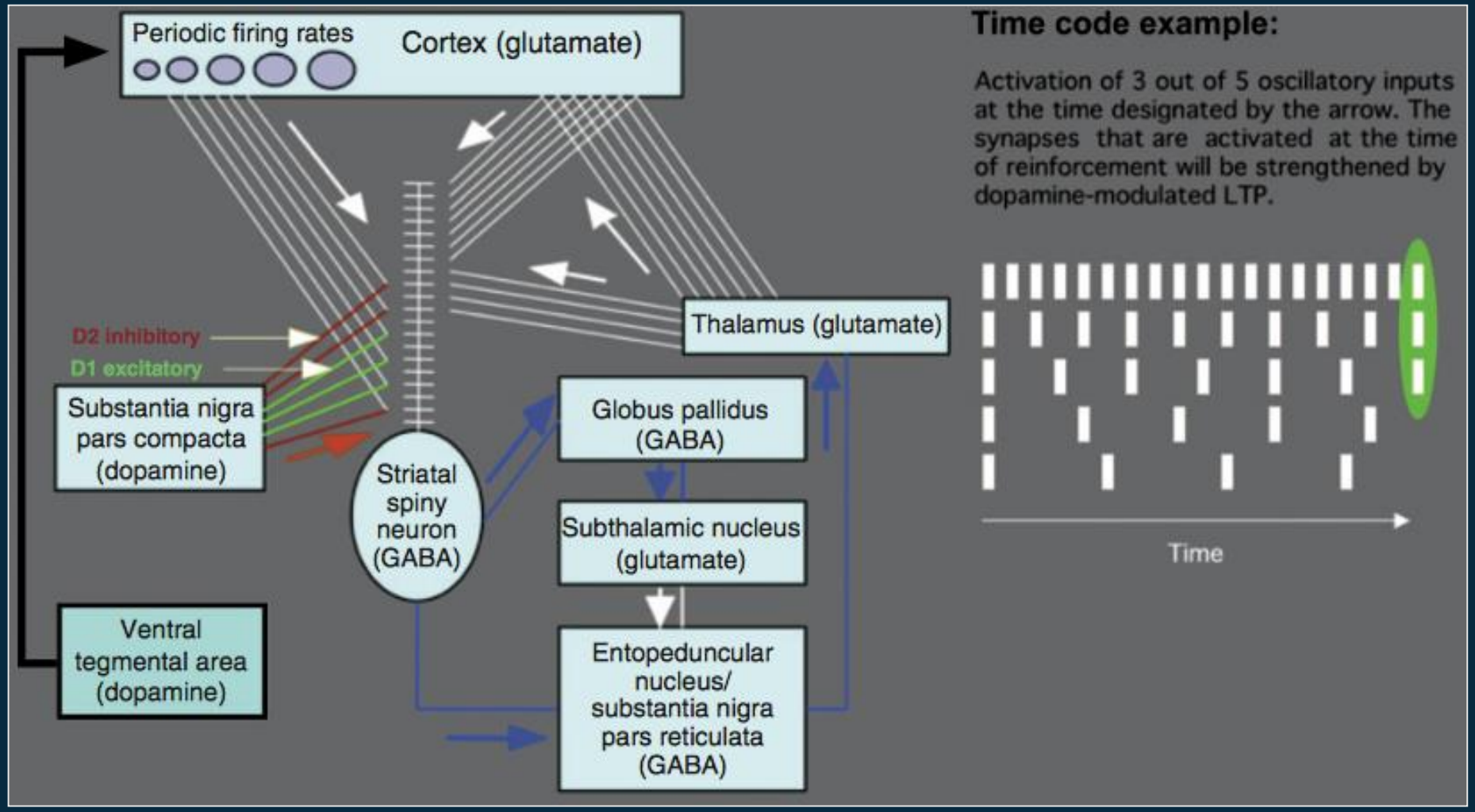


Figure 1 The information processing model of interval timing as specified by scalar expectancy theory. Adapted from Gibbon *et al.* (1984).

Allman & Meck, 2012.

Striatal beat frequency model



Allman & Meck, 2012.

DISCUSSION

Conditions Where Time Perception Can Become Distorted

- Parkinson disease
- Schizophrenia
- Autism
- ADHD
- Drugs: stimulants, depressants, psychedelics

Parkinson's Disease

- Pathologic changes in time perception noted: slowing of time. Severity of perceived difference correlated with severity of cardinal Parkinson's disease symptoms
- Atrophy of the substantia nigra
- Depletion of dopamine releasing neurons that project to the caudate–putamen (in basal ganglia)
- Basal ganglia – crucial for timing in subsecond and suprasecond ranges, per multiple studies

Allman & Meck, 2012. Pathophysiological distortions in time perception and timed performance. *Brain,* 135: 656-677

Schizophrenia

- Some characterize it as disorder of temporal coordination of information processing, or have a 'General' temporal processing deficit
- Chronic antipsychotic meds => more difficulty estimating duration/timing of visual signals
- Auditory stimuli is perceived to be faster than actual duration. Visual stimuli is perceived to be slower than actual duration.
- Neurophysiology: Lower levels of activation in supp motor area, insula/opercula, striatum, which are all involved in time perception, in theory.

Allman & Meck, 2012. Pathophysiological distortions in time perception and timed performance. *Brain,* 135: 656-677

Autism

- Surveys of parents – their autistic child has "poor" sense of time
- Studies show tendency to truncate longer durations
- Neurophysiology: abnormal functioning of prefrontal cortex, basal ganglia, cerebellum
- Abnormalities in dopamine, serotonin have been implicated

Allman & Meck, 2012. Pathophysiological distortions in time perception and timed performance. *Brain,* 135: 656-677

ADHD

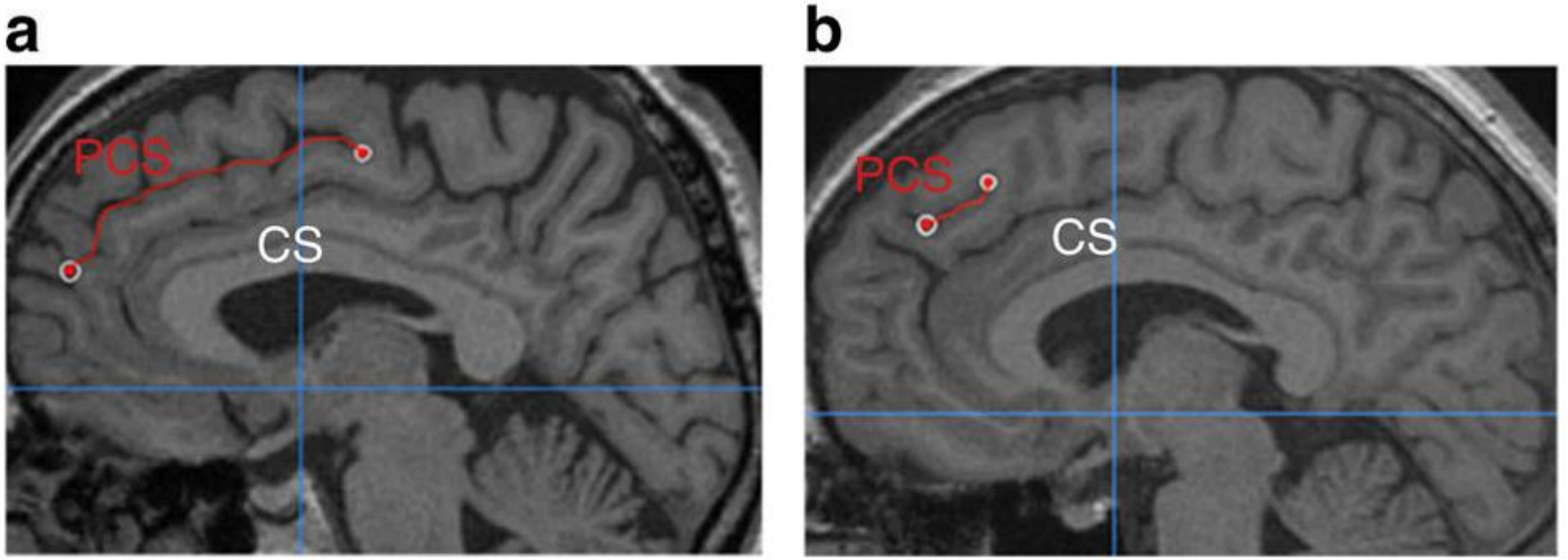
- Tend to underestimate durations
- Study of nicotine in ADHD:
  - Nicotine increases attention deficits by affecting DA release in striatum and prefrontal cortex
  - Nicotine also helped to improve estimation of timing

Allman & Meck, 2012. Pathophysiological distortions in time perception and timed performance. *Brain,* 135: 656-677

Imagination vs. Reality

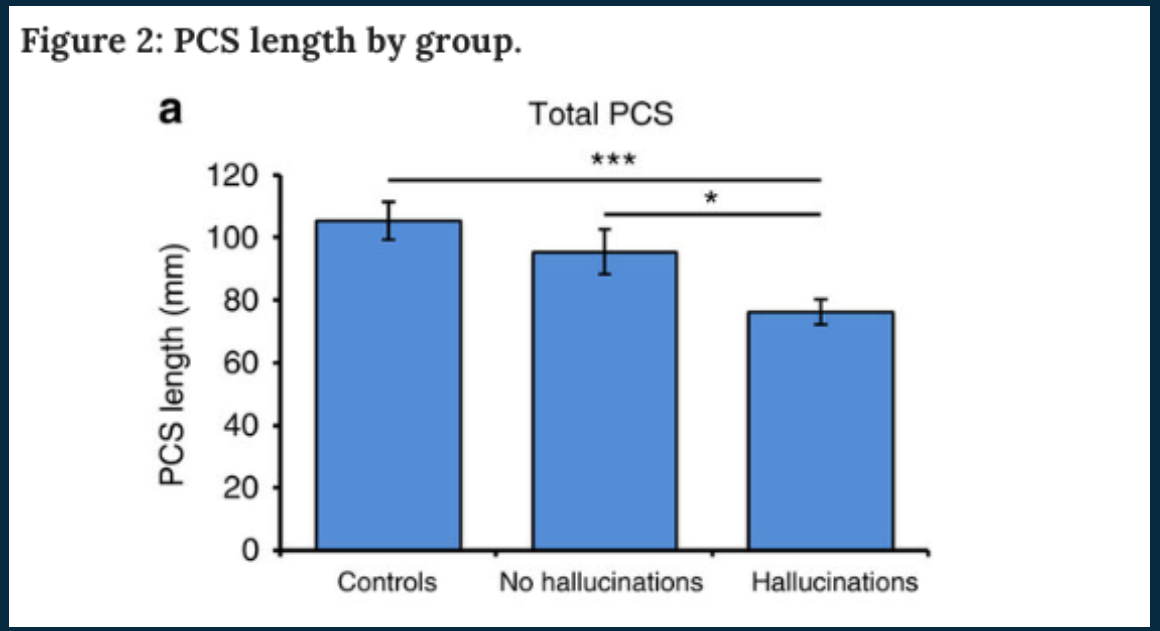
Figure 1: PCS measurement for two example images.

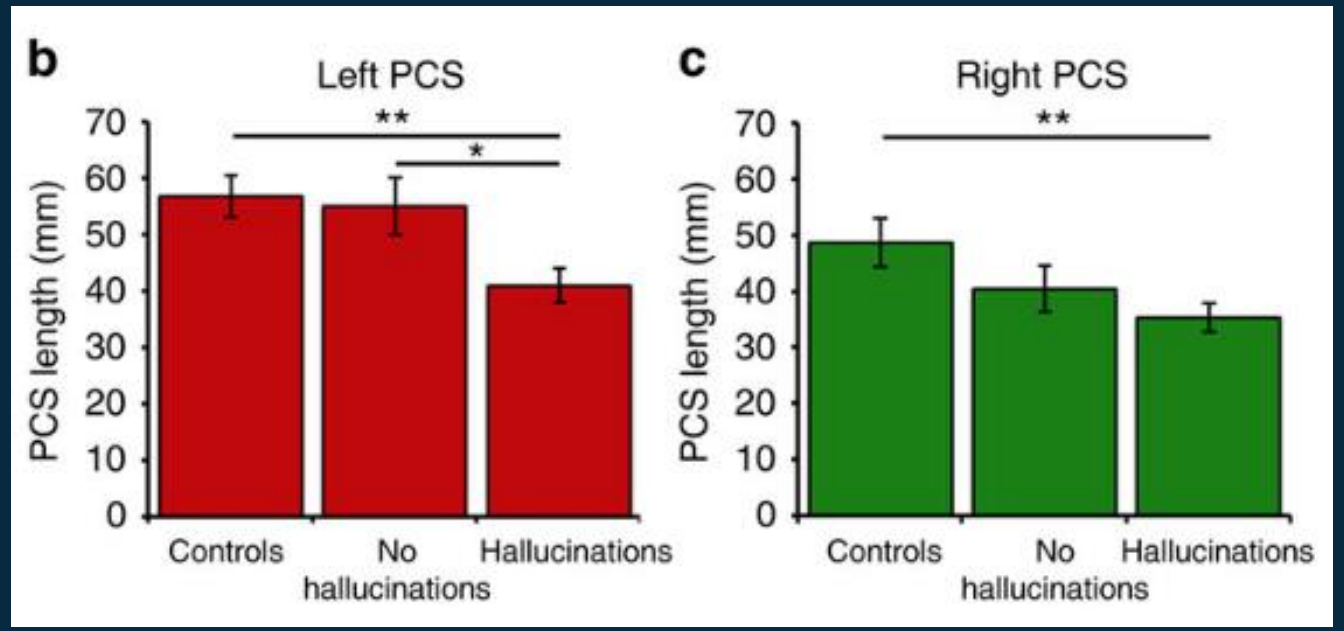
From: Paracingulate sulcus morphology is associated with hallucinations in the human brain



Garrison, J. R. *et al*. 2015. Paracingulate sulcus morphology is associated with hallucinations in the human brain. *Nat. Com*

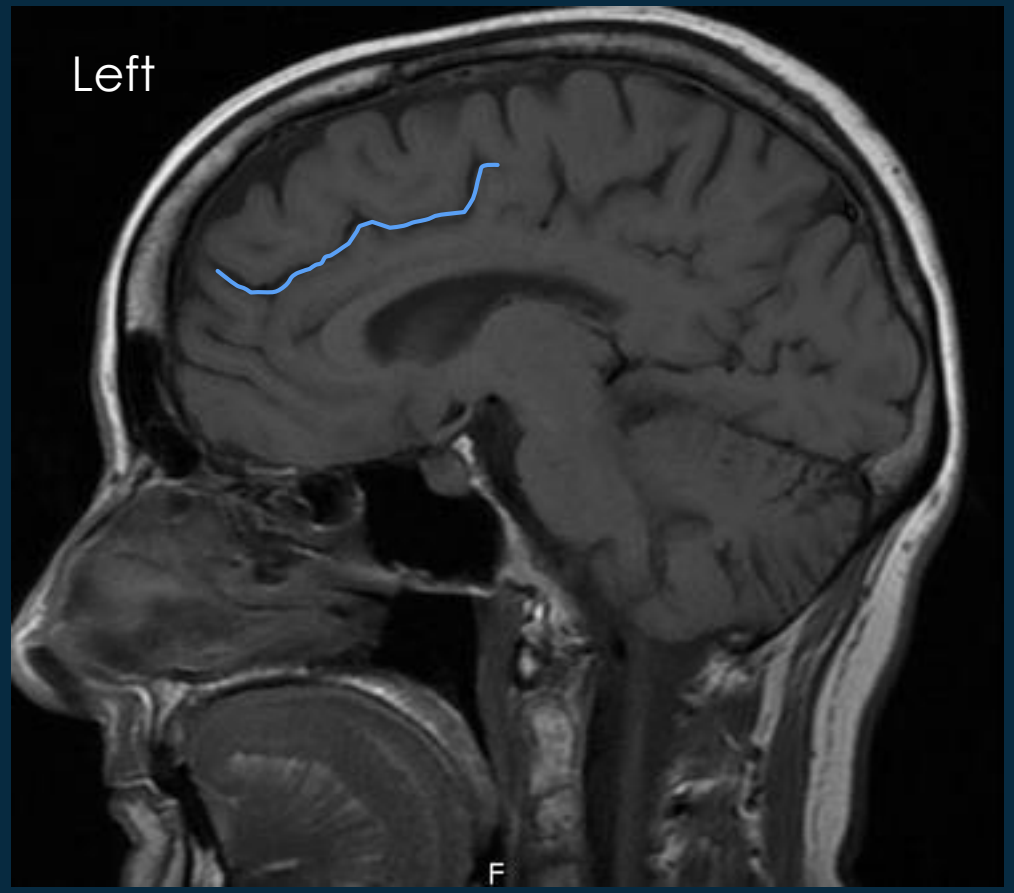
A 1 cm reduction in sulcal length increases the likelihood of hallucinations by **19.9%**

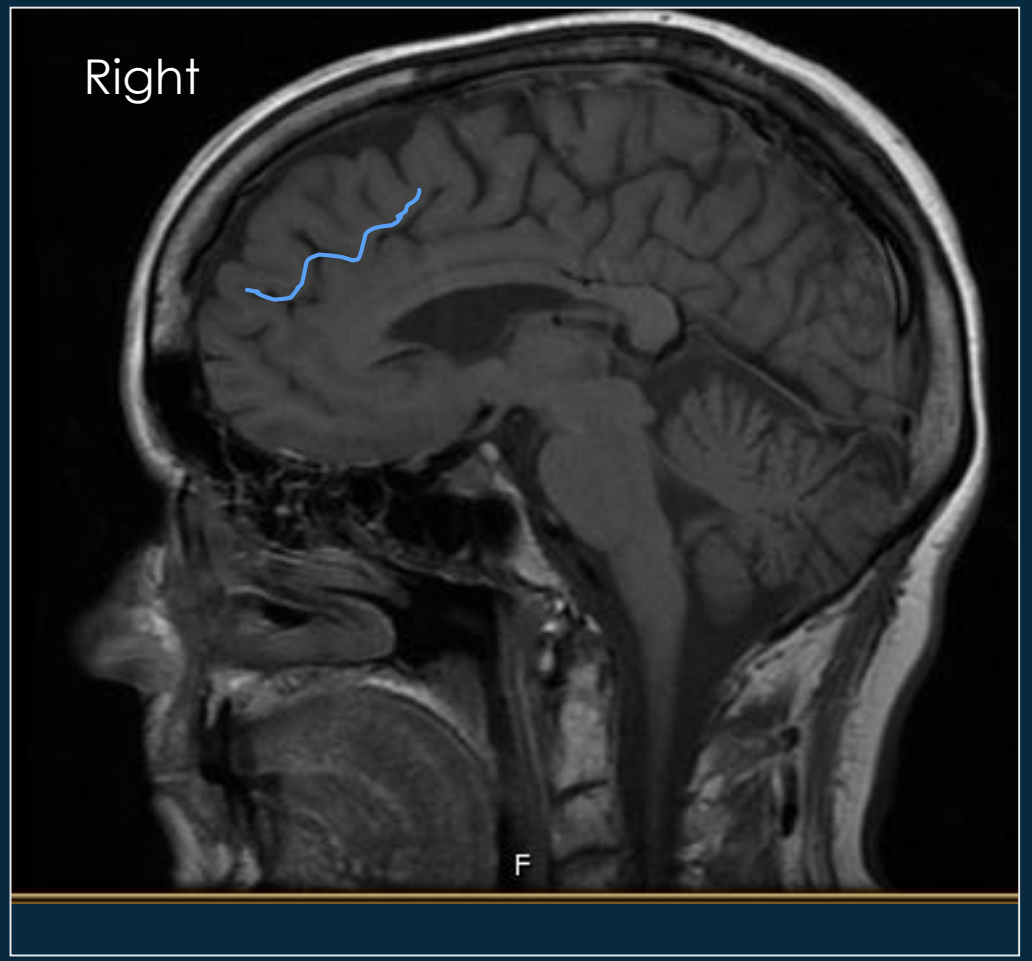




Garrison, J. R. *et al*. 2015. Paracingulate sulcus morphology is associated with hallucinations in the human brain. *Nat. Com*

Patient's Brain and PCS





Immediate Intervention

- Discussed possible **etiologies**
- Be honest about **theoretical** nature
- If secondary to stroke – **prognosis**
- Immediate **results** - "I'm feeling much better knowing it's from the stroke"

4-Week Follow-Up

- Overall improvement since coming home
- One instance of “hallucinations” that were not distressing
- PFO closure beginning of October - decreased anxiety

References

- **Allman & Meck, 2012. Pathophysiological distortions in time perception and timed performance. *Brain*, 135: 656-677**
- Matthews & Meck, 2016. Temporal cognition: connecting subjective time to perception, attention, and memory. *Psychological Bulletin*, 142(8): 865-907
- Meck W & Benson A, 2002. Dissecting the brain's internal clock: how frontal-striatal circuitry keeps time and shifts attention. *Brain and cognition,* 48(1): 195-211
- Meck, 2005. Neuropsychology of timing and time perception. *Brain and Cognition,* vol 6(1): 1-8
- Giedd et al. 2000. MRI assessment of children with obsessive-compulsive disorder or tics associated with streptococcal infection. *Am J Psychiatry,* 157: 281-283
- Johnson, Goel, & Buonomano, 2010. Neural dynamics of in vitro cortical networks reflects experienced temporal patterns. *Nature Neuroscience,* 13(8): 917-919.
- Garrison, J. R. *et al*. 2015. Paracingulate sulcus morphology is associated with hallucinations in the human brain. *Nat. Communication*
- Buda, M., Fornito, A., Bergstrom, Z. M. & Simons, J. S. A specific brain structural basis for individual differences in reality monitoring. *J. Neurosci.* **31**, 14308–14313 (2011)