

## Background

### Implicit learning

- Non-declarative learning
- Does not require explicit teaching
- “learning without trying”

### Language

- Rule guided behavior acquired through implicit learning

### Automatization:

- After long periods of practice behaviors become automatic
- Established model for motor skills

### Stroke

- Leading cause of serious long-term disability
- Aphasia affects up to 38% of stroke survivors
- Results in neuronal cell death from either hemorrhage (hemorrhagic stroke) or occlusion (ischemic)

### Caudate head

- Working memory and executive function
- Association or Categorical learning
- Cognitive and emotional regulation
- Reward

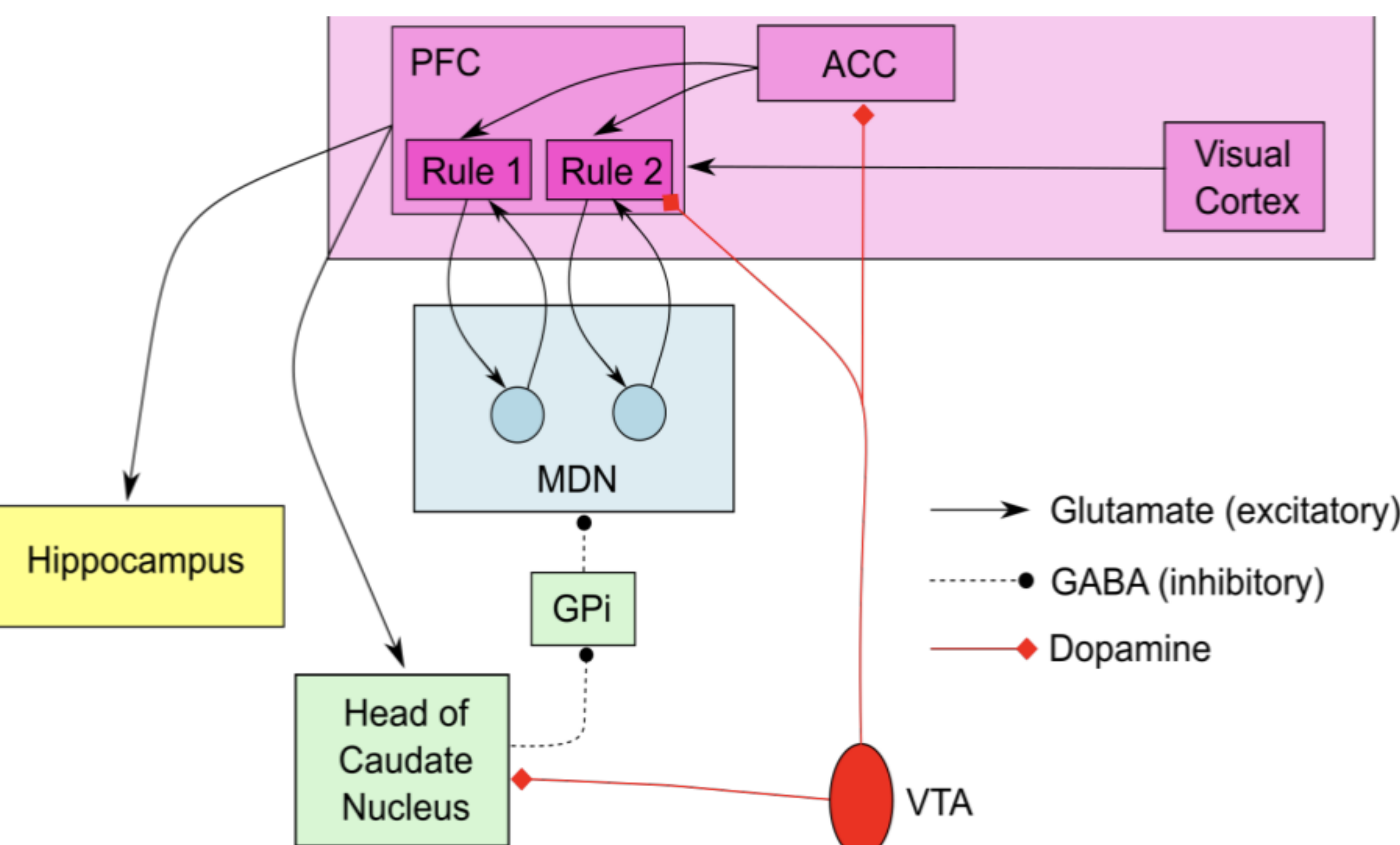
### Lesion segmentation

- Methodology to model the structural damage associated with stroke
- Uses T1 weighted MRI data and manual segmentation to assess damage

## The Model

### CARM+ Model

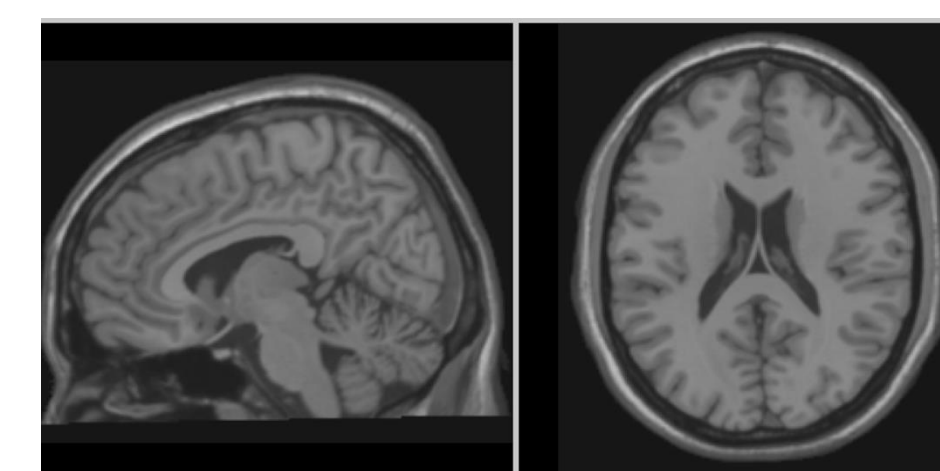
- Biological computational model proposed by Kovacs et al 2021<sup>3</sup>
- 3 “layers” to automaticity<sup>3</sup>
  - Working memory executive function and prefrontal cortex (PFC)
  - Reverberation between caudate head and PFC
  - PFC for automatization



## Experimental design

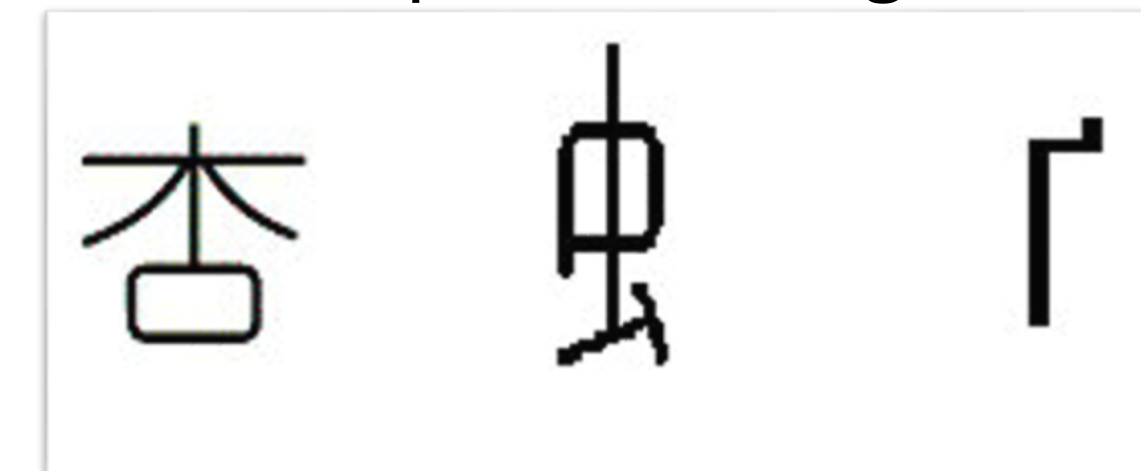
### Imaging:

Imaging was collected through the University of Pittsburgh for seven participants. Participant 5 had their imaging collected through the UNH CoBALT lab at the Boston University scanner. All participants underwent resting states functional MRI (rsfMRI). Only the structural data was used in this project. All participants were over 55 with left hemisphere stroke



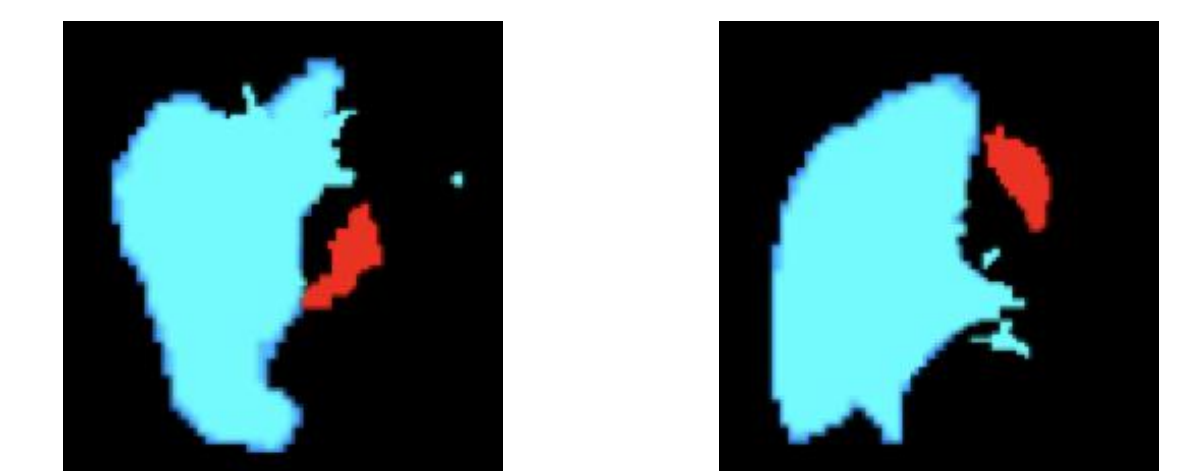
### Implicit learning task:

Over 2 hours participants partook in Implicit Learning in Recovery for Acquired Communication Disorders (INNOVATE) protocol. This looked at two modalities of implicit learning including visual and auditory tasks. Both tasks were administered twice with 45 minutes in-between and used  $d'$  as a sensitivity index to determine if implicit learning had occurred



### Data analysis:

Structural data was run through Brainlife software to normalized into ACP aligned space. The caudate head region used was sourced from the Mango MNI atlas and also transformed into ACPC space. The lesions were transformed using FLIRT and overlaid with the region of interest using MRICron to determine percent overlap.



## Results

Participant	Age at Testing	EDI LQ	d' Aud 1	d' Aud 2	d' Vis 1	d' Vis 2	% Caudate overlap
1	74	1.00	2.55	1.02	0.22	0.55	0.00%
2	83	1.00	1.22	1.24	0.22	0.78	0.00%
3	76	-0.60	0.00	0.11	0.34	0.55	0.08%
4	63	0.71	0.67	-0.71	0.43	0.43	0.00%
6	66	1.00	0.38	0.00	1.24	0.00	0.00%
8	59	0.58	0.22	0.00	0.55	0.11	0.00%
9	74	1.00	0.00	-0.46	1.29	1.29	0.00%
5*	59	88.89	0.81	0.11	-2.34	1.22	0.00%

Table 1: Patients calculated  $d'$  on each implicit learning task and associated caudate head lesion overlap percentage

\*\*Values of 1 or greater indicate learning occurred

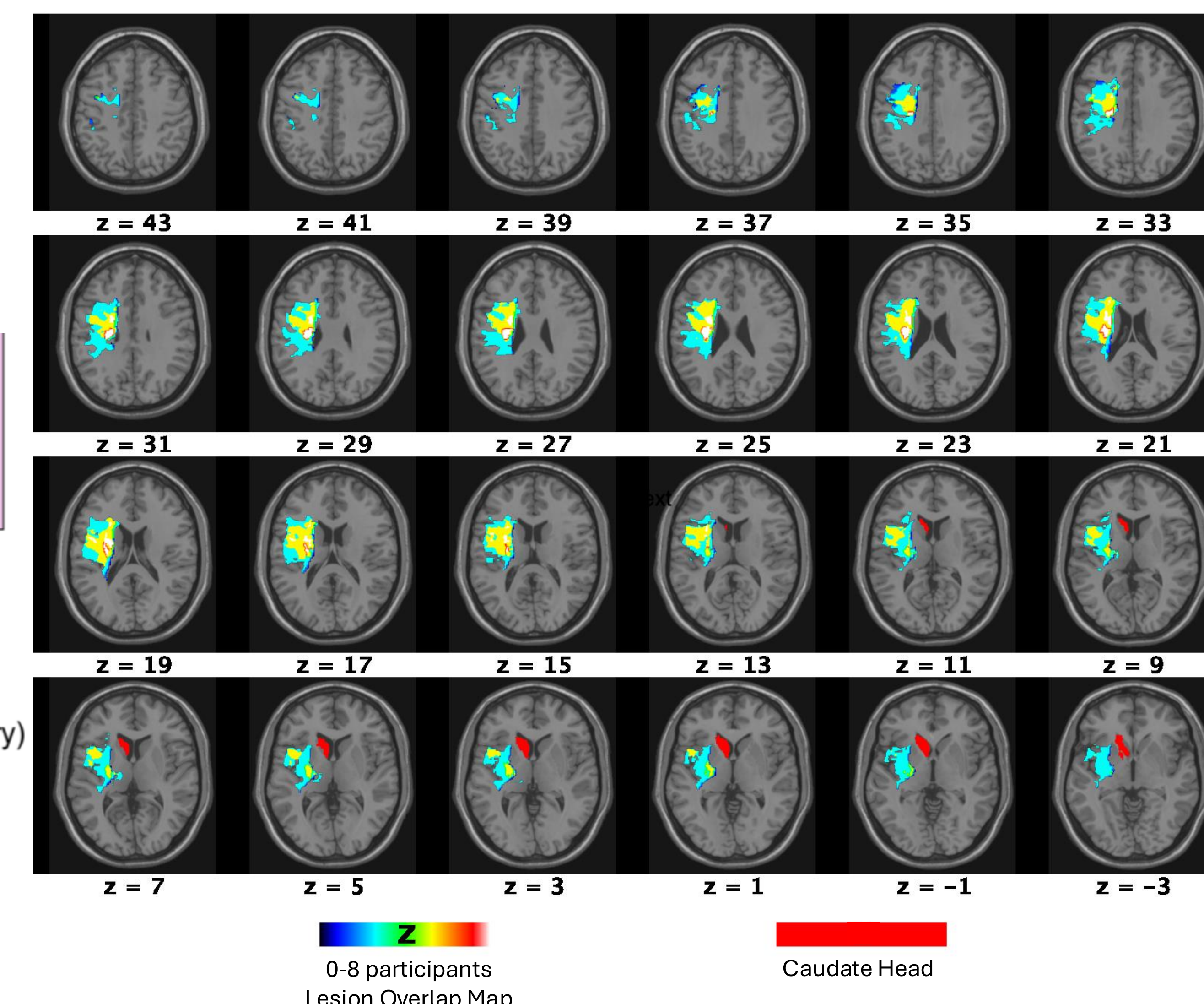


Image 1: Caudate Head ACPC aligned ROI

This study was unable to find any significant findings validating the role of caudate head in automaticity. There were some clear discrepancies in performance, however, there was not sufficient evidence to determine caudates role in these discrepancies.

## Limitations and Future Directions

- Lack of overlap between caudate head and lesions
- This was an incredibly small sample size, in order to increase the power of this study there should be further research using a greater sample size.
- Functional connectivity to see the extent of network damage

## Acknowledgments

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## References

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