Absence of Perilesional Neuroplastic Recruitment in Chronic Poststroke Aphasia

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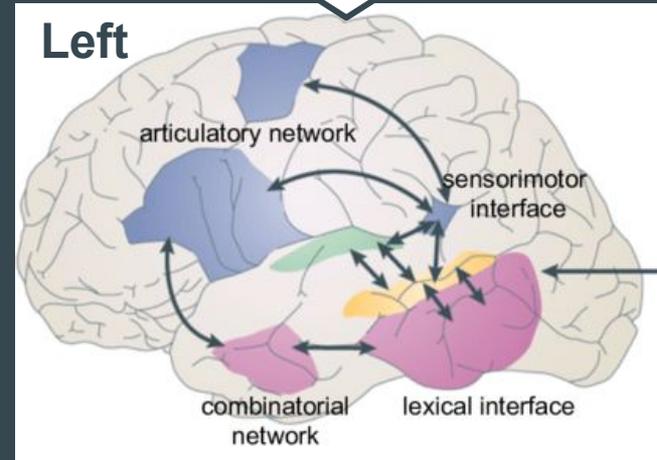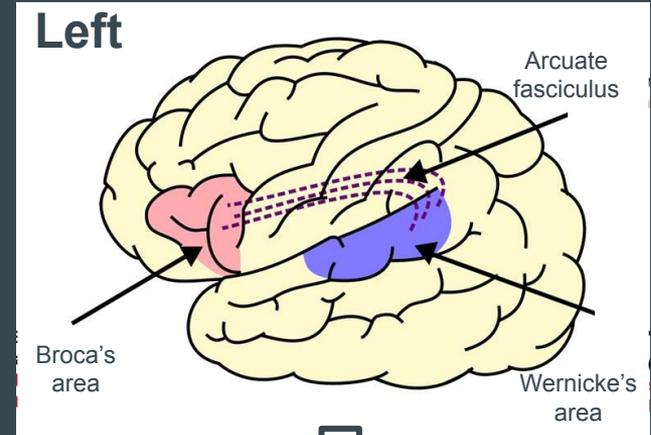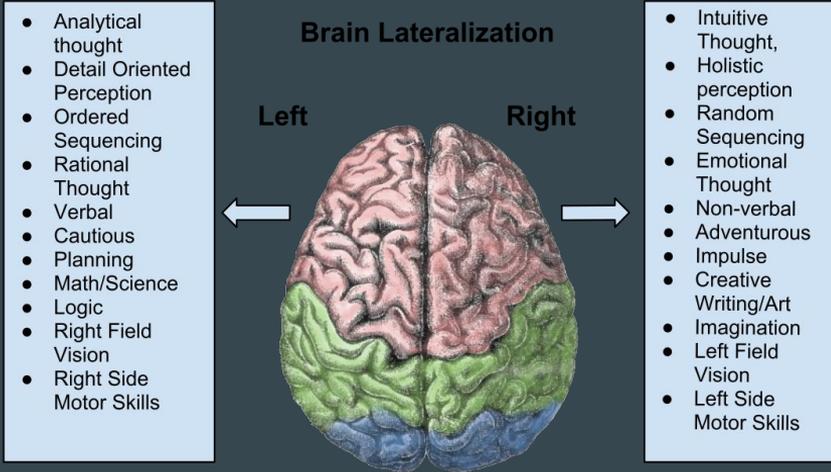
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Language in the brain

- Analytical thought
- Detail Oriented Perception
- Ordered Sequencing
- Rational Thought
- Verbal
- Cautious
- Planning
- Math/Science
- Logic
- Right Field Vision
- Right Side Motor Skills

Brain Lateralization

Left　　　Right

- Intuitive Thought,
- Holistic perception
- Random Sequencing
- Emotional Thought
- Non-verbal
- Adventurous
- Impulse
- Creative Writing/Art
- Imagination
- Left Field Vision
- Left Side Motor Skills

Left

Arcuate fasciculus

Broca's area

Wernicke's area

Left

articulatory network

sensorimotor interface

combinatorial network

lexical interface

# Perilesional plasticity in post-stroke aphasia

- Stroke leading cause of permanent disability, and sequelae partially determined by lesion size/location

- However, important driver of recovery is thought to be reorganization in tissue beyond lesion boundary (Grefkes & Fink, 2020)

- Mechanistic account of plasticity necessary for progress in aphasia neurorehabilitation; several mechanisms proposed (Stefaniak et al., 2020; Turkeltaub, 2019)

Left-hemisphere mechanisms

  - Perilesional plasticity (Fridriksson et al, 2010, 2012)
  - Normalization of network dysfunction (Saur et al., 2006)

Perilesional plasticity hypothesis

- Emphasizes <u>tissue immediately surrounding lesion</u>
  - animal studies have observed dysfunction
    (Neumann-Haefelin & Witte, 2000; van der Zijden et al., 2008)

  - collateral axonal sprouting and synaptogenesis may support functional recovery (Nudo, 1999; Stroemer et al., 1995)

  - motor stroke recovery relies on functional take-over by perilesional sensorimotor (Teasell et al., 2005) or primary motor cortices (Jaillard et al., 2005; Xerri et al., 1998)
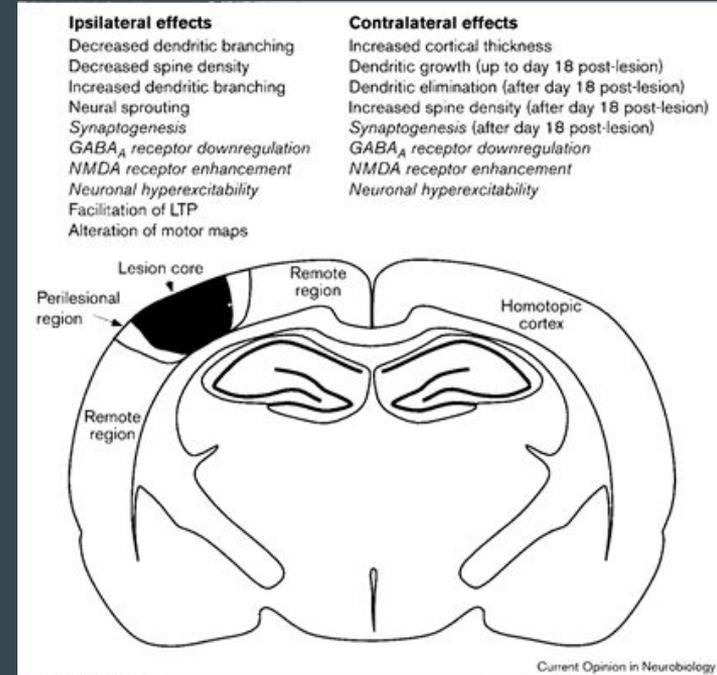
(Nudo, 1999)

Aim: What is perilesional activation?

Neuroplastic recruitment of new tissue beyond typical language roles

- Activity should be greater than controls
- May occur outside typical language regions
- Increased activity with small lesions, not large lesions
- Activation relates to behavior

**Normalization of activity in a dysfunctional language network**

- Activity should be same or reduced compared to controls
- Should occur in typical language regions (perilesional and beyond)
- Reduced activity with large lesions
- Activation relates to behavior

Are alternate left hemisphere processers recruited?
Do these effects generalize across language tasks?
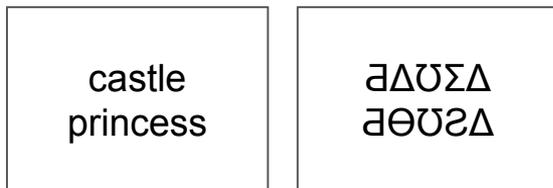
Methods - Tasks and participants

Two fMRI language mapping tasks

spoken picture-naming task
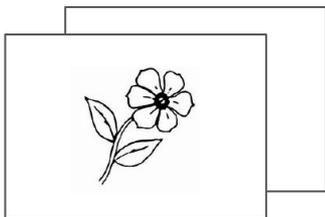
Patients N = 51, controls = 41

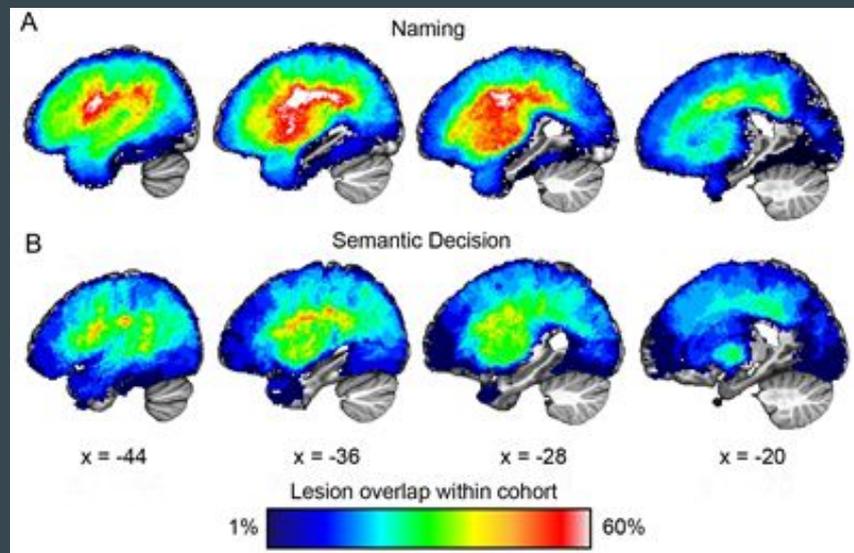adaptive semantic decision task

castle
princess

ꟼΔᴜꙄΔ
ꟼƟᴜꙄΔ

(Wilson et al., 2018)

Patients N = 31, controls = 41

(all patients >6 mo post-stroke, hx of aphasia)

A   Naming

B   Semantic Decision

x = -44   x = -36   x = -28   x = -20

Lesion overlap within cohort
1%   60%

- Examine fMRI activity in
  - language areas
  - language-capable areas
  - non-language areas

Defining lesioned tissue and perilesional tissue

- Anatomical lesions manually traced

- Dilation model of perilesional tissue (Fridriksson et al., 2012) - perilesional tissue defined as shell falling outside individual's anatomical lesion tracing

  - For brainwide questions, 4mm-thick shells spanning 0-4mm, 4-8mm, 8-12mm, and 12-16mm from lesion boundary
  - Further analyses considered perilesional (vs distance) tissue as single slab between 4-16mm from lesion boundary
  - All analyses restricted to left-hemisphere gray-matter

Group activation consistency

A — Naming — Controls

D — Semantic Decision — Controls

B — Patients

E — Patients

C — Masks

F — Masks

x = -52   x = -44   x = -36

x = -52   x = -44   x = -36

% activating (P < .001, unc)

25%   75%
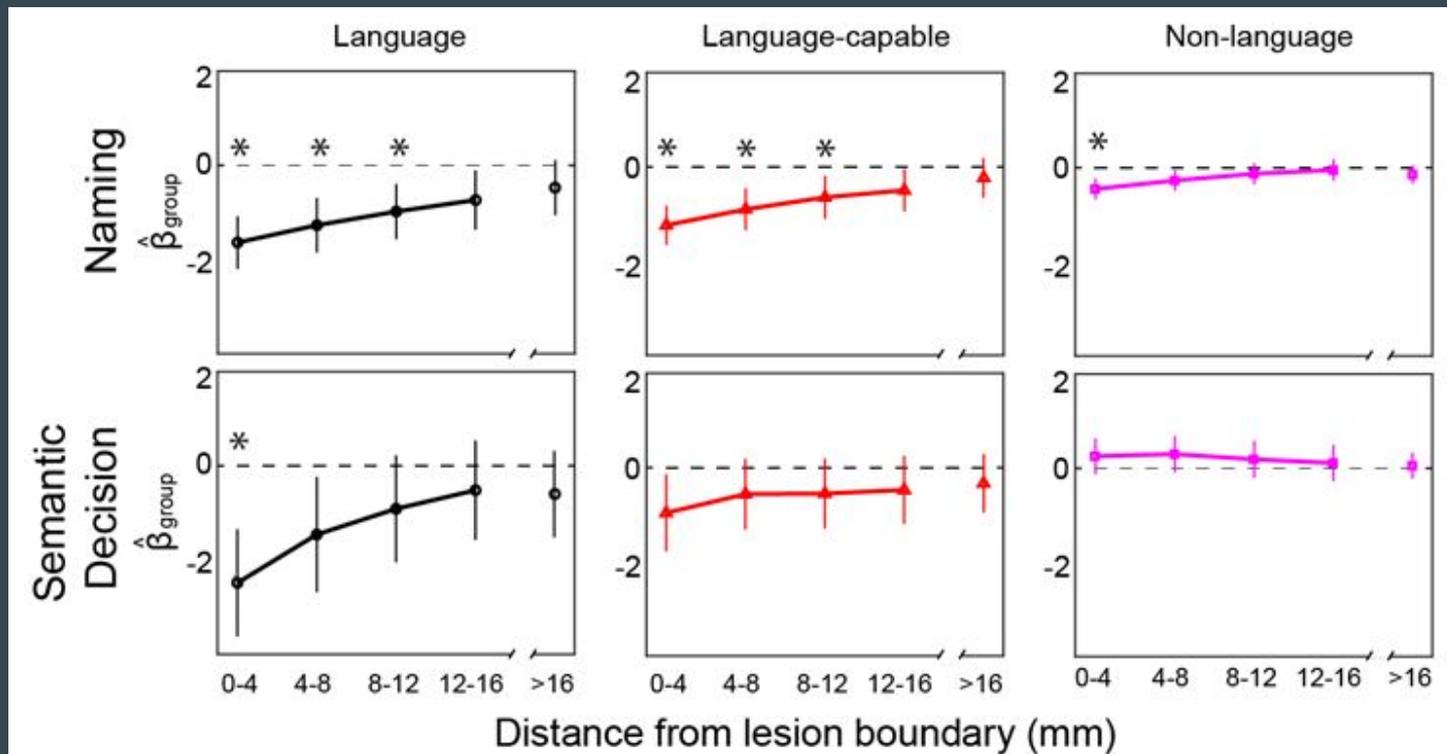
■ Language   ■ Language-capable
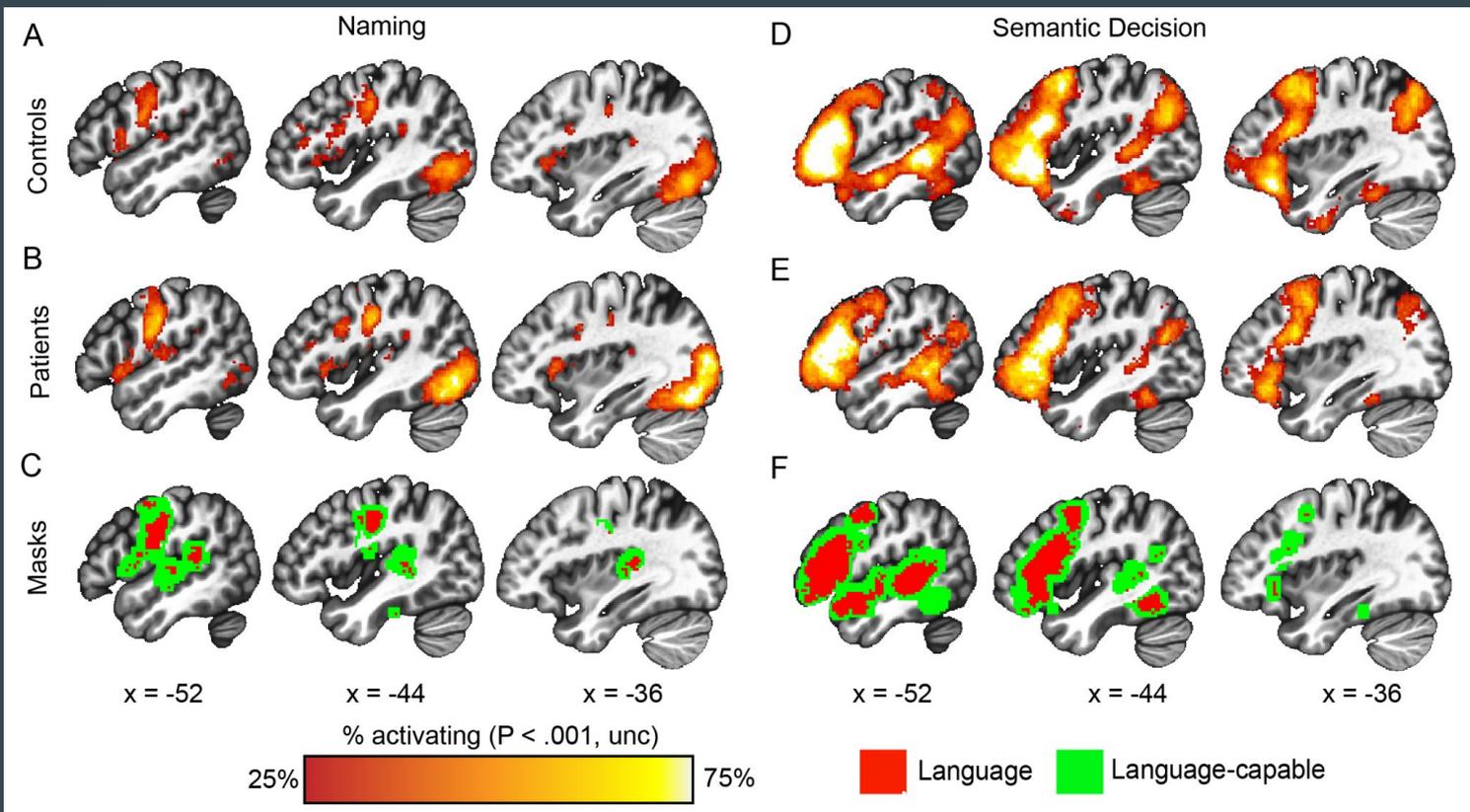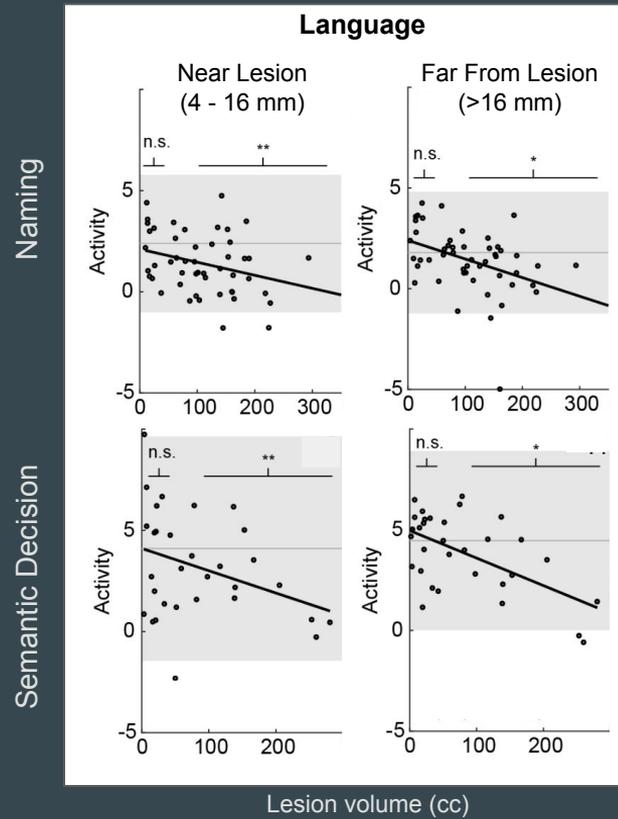
*Neurosynth mask

Individualized Tissue Categorization
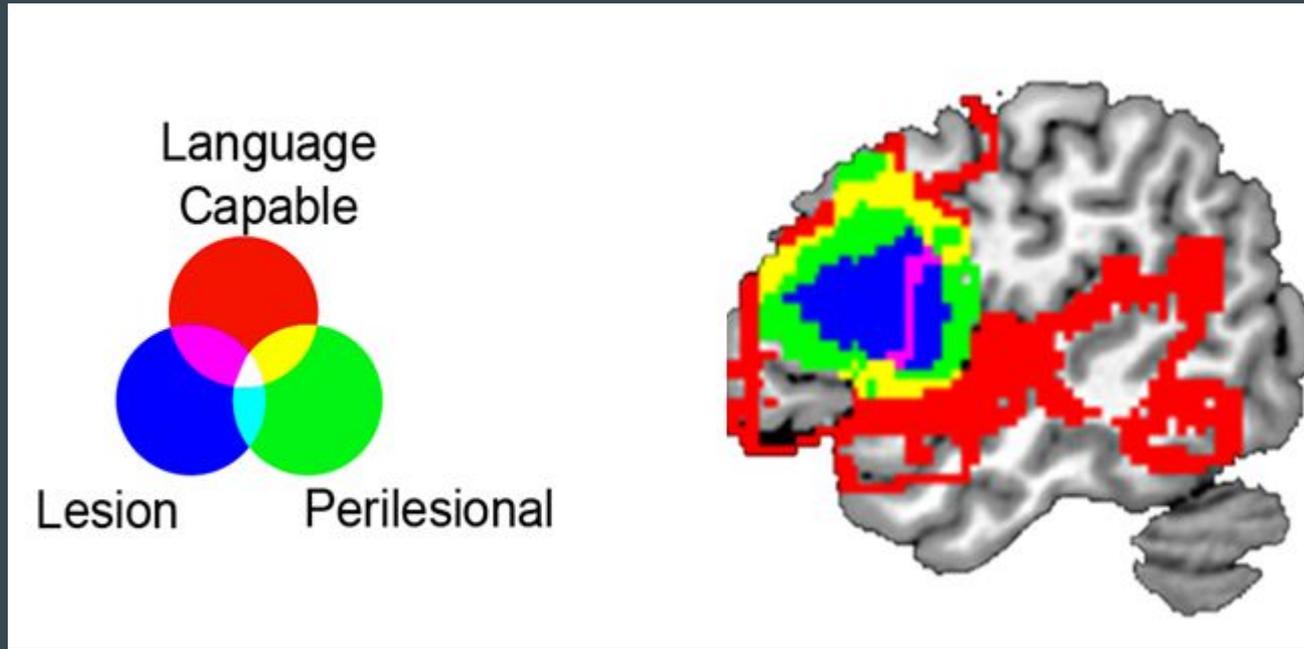
Examine each individual's perilesional tissue in all controls
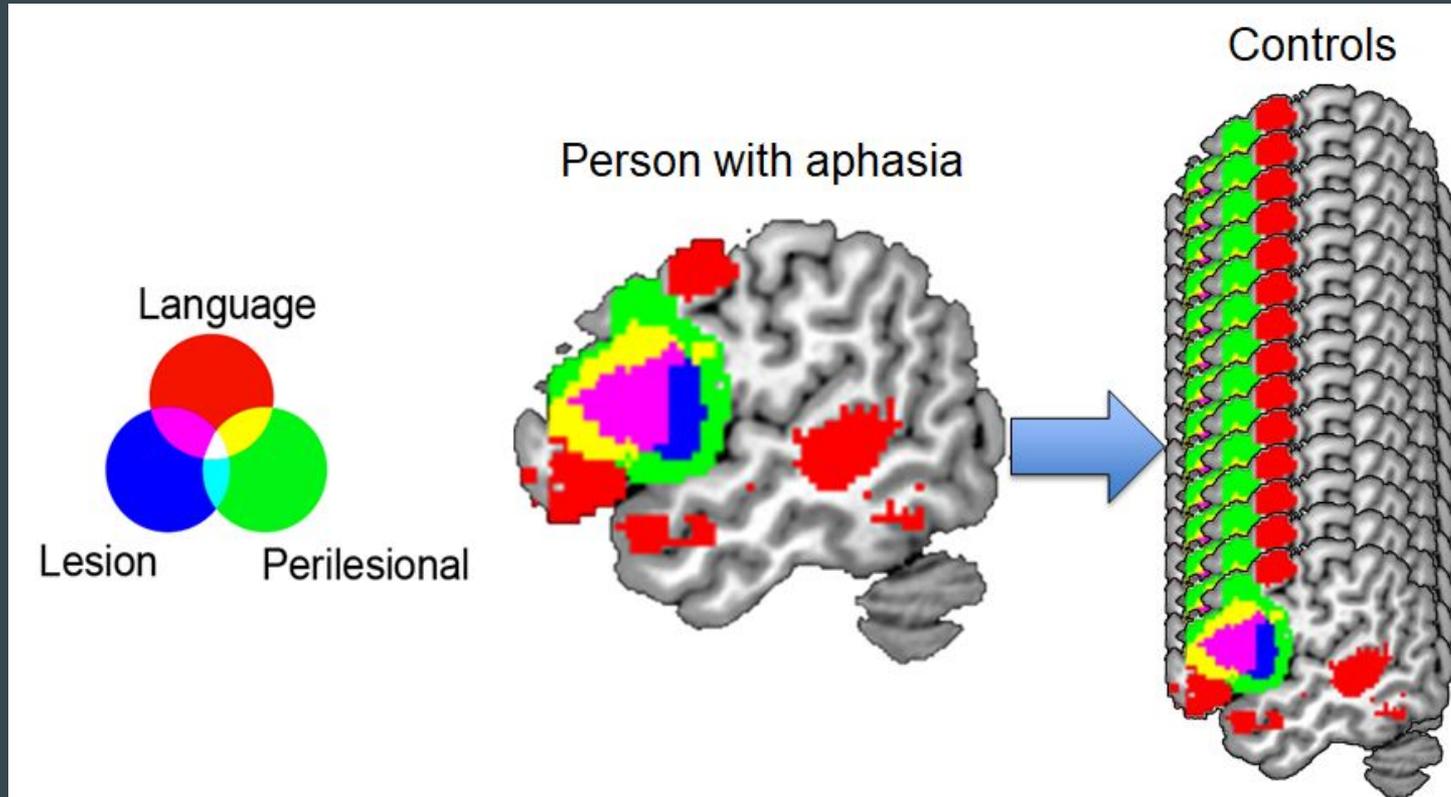
Is there recruitment of perilesional tissue above normal levels?

What about supranormal activity when lesions are small?

Language

Near Lesion (4 - 16 mm) · Far From Lesion (>16 mm)

Naming · Semantic Decision

Activity · Lesion volume (cc)

small lesions <50 cc

large lesions >150 cc

* $P < .05$
** $P < .001$

Does disrupted activity account for behavioral impairment?[†]

	Near Lesion (4 - 16 mm)	Far From Lesion (>16 mm)
Naming	$r(49) = .24$ $P = .10$	$r(50) = .18$ $P > .10$
Semantic Decision	$r(30) = .45$ $P = .01$	$r(31) = .43$ $P = .01$

[†]Western Aphasia Battery

Is perilesional activity increased only in specific brain areas?
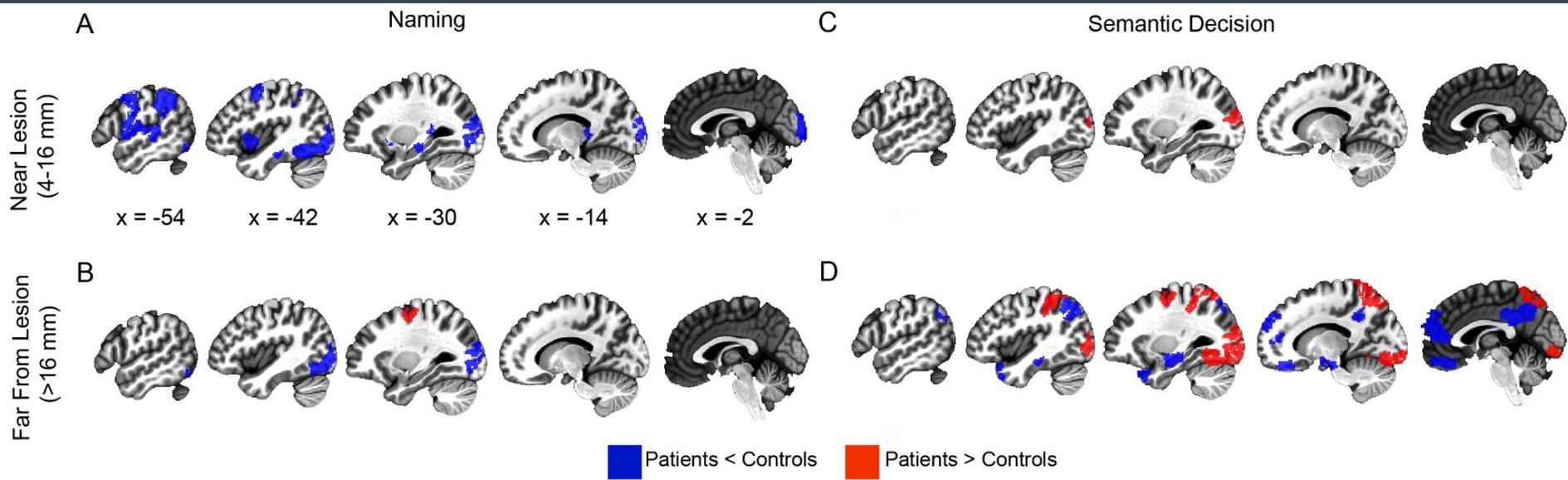
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Conclusions

- <u>We did not find</u> evidence for perilesional plasticity measured by BOLD fMRI in two groups of people with chronic aphasia using different tasks

- <u>We did find</u> evidence for lesion-size dependent language network dysfunction, suggesting normalization of fMRI task activity may explain some conclusions from previous studies

- Results place constraints on mechanistic accounts of chronic post-stroke aphasia neuroplasticity measured with BOLD fMRI

- **But findings limited by <u>use of task</u> and focus on <u>only perilesional tissue</u>**

Plug for Georgetown's Neuroscience of Language T32!

https://neurolang.georgetown.edu/

Acknowledgements