

# **Noninvasive and Targeted Brain Drug Delivery using Transcranial Focused Ultrasound**

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**SCIT Seminar**

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# Outline

## ❖ Existing Approaches for Brain Drug Delivery

### 1. Vascular Opening

(Focused Ultrasound + Microbubbles)

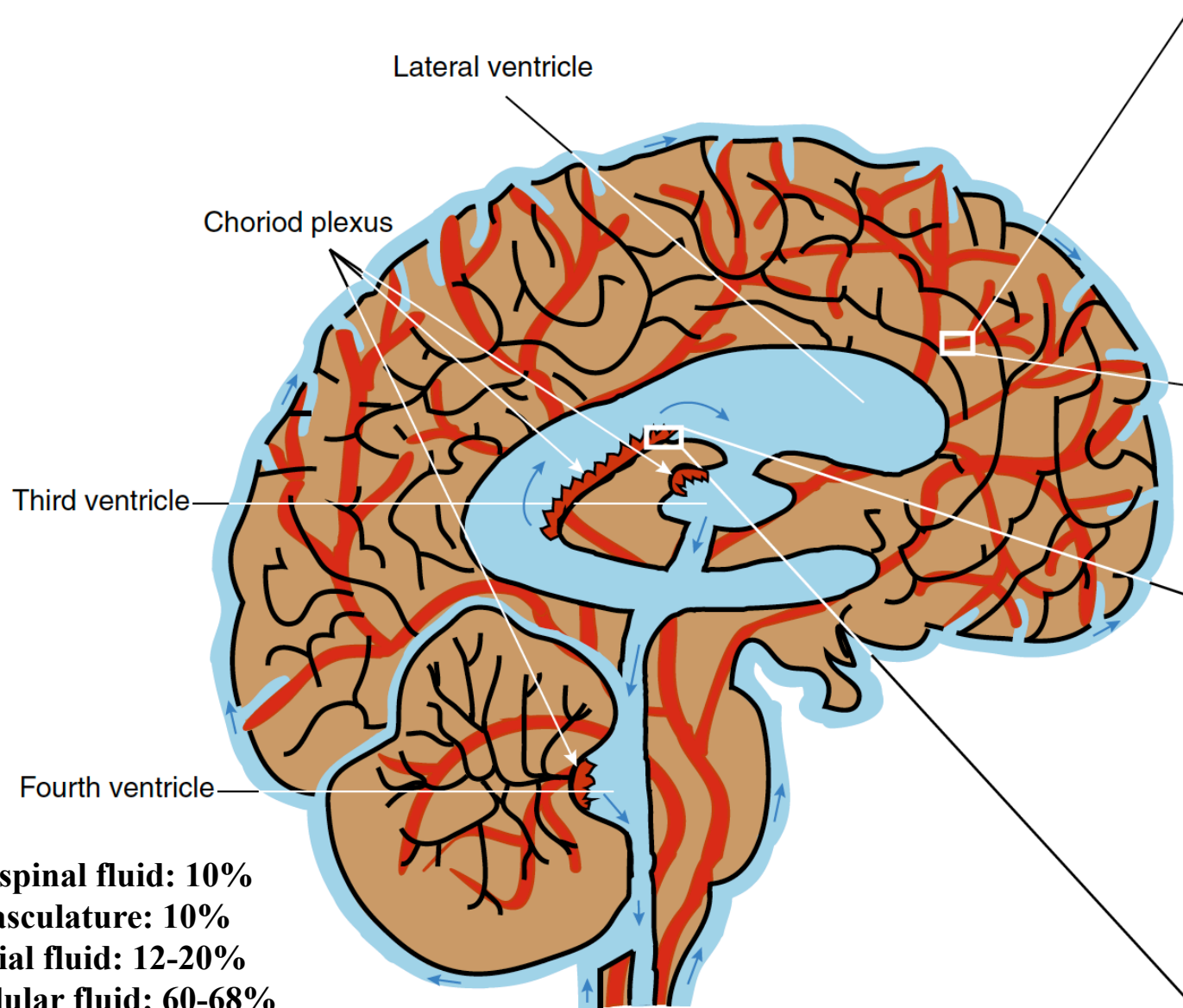
### 2. Without Vascular Opening

(Focused Ultrasound + Nanodroplets)

## ❖ New Approach for Brain Drug Delivery

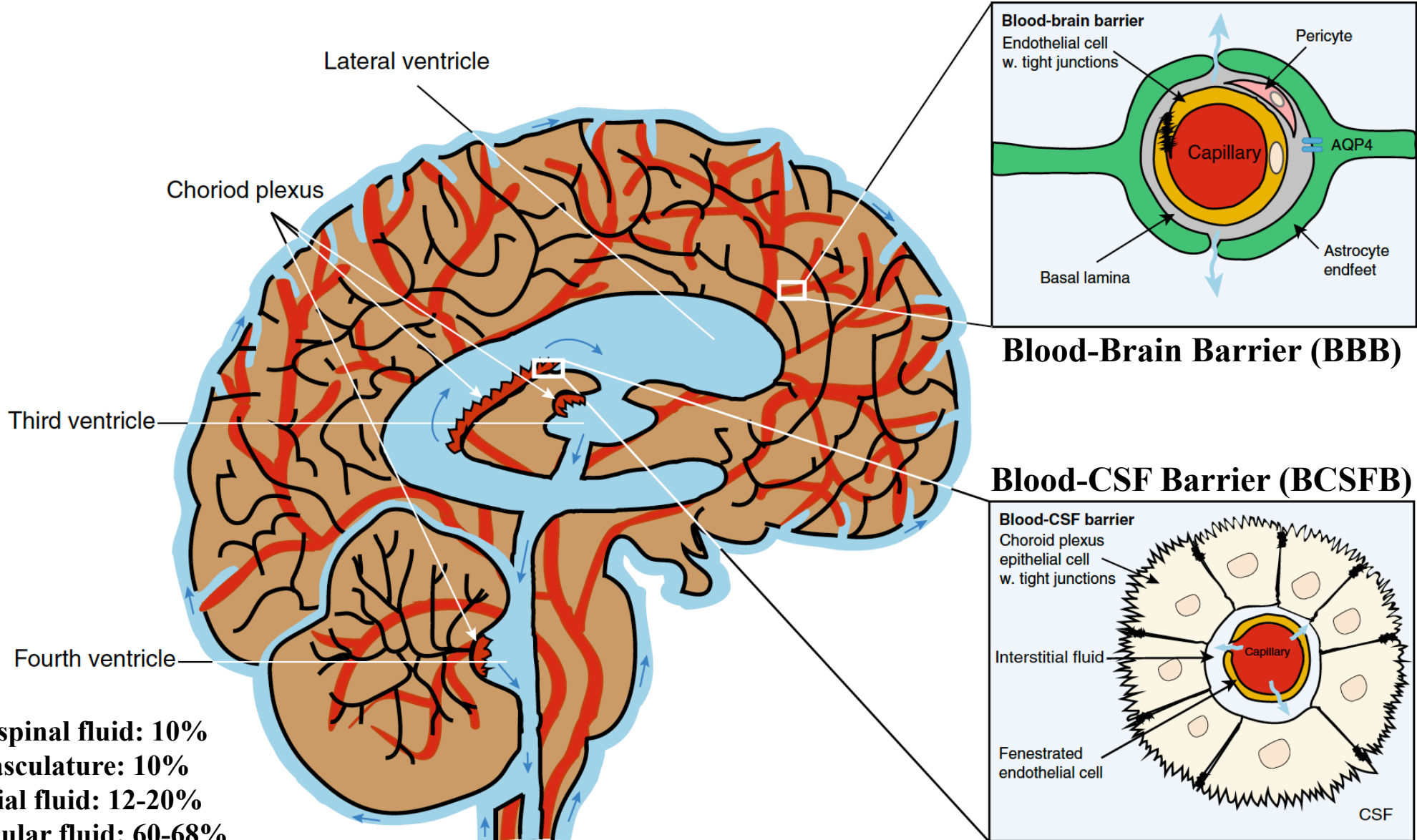
## ❖ Conclusions

# Brain's Fluid Compartments and Barriers



1. Cerebrospinal fluid: 10%
2. Blood vasculature: 10%
3. Interstitial fluid: 12-20%
4. Intracellular fluid: 60-68%

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However, those vascular barriers, the BBB, and the BCSFB limit drug delivery for neurological disorders.

# Approaches for Brain Drug Delivery

- **Invasive**



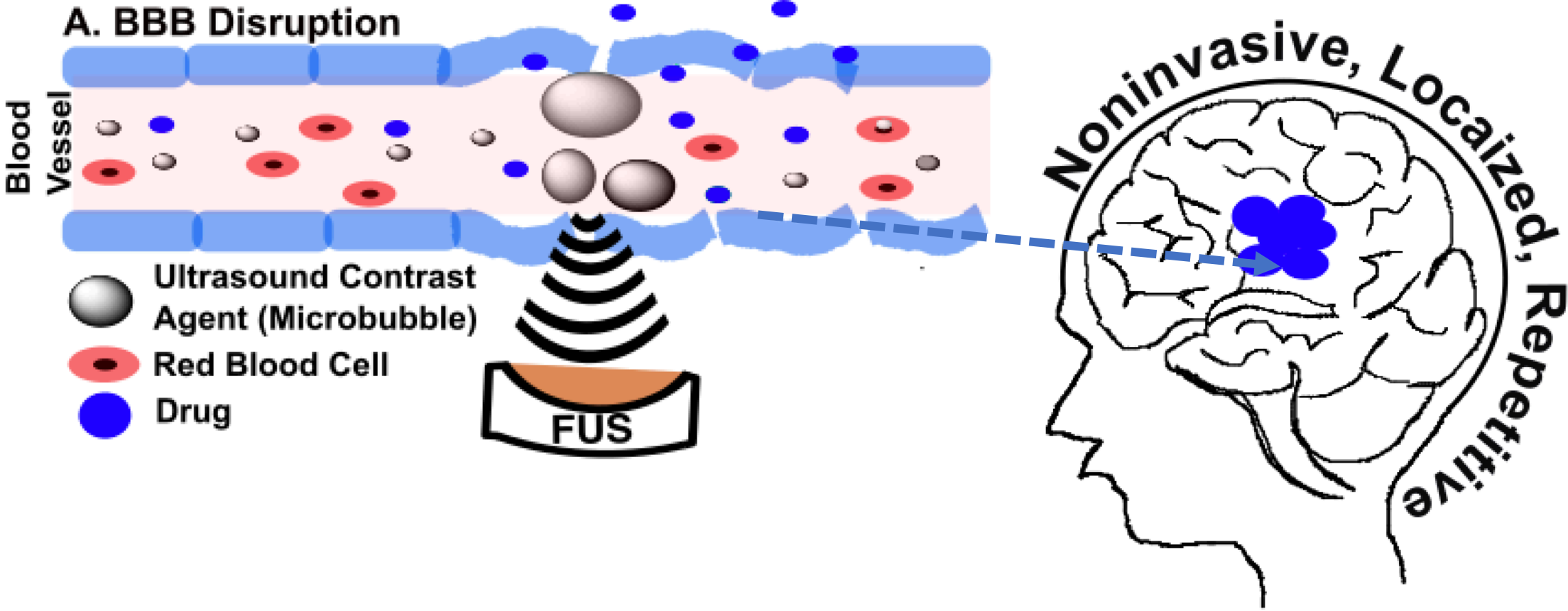
- ❖ Direct Injection
- ❖ Implantable devices
- ❖ Intrathecal/Intraventricular Injection
- ❖ BBBD via arterial injection of osmotic solution

- **Trans-Nasal Delivery**

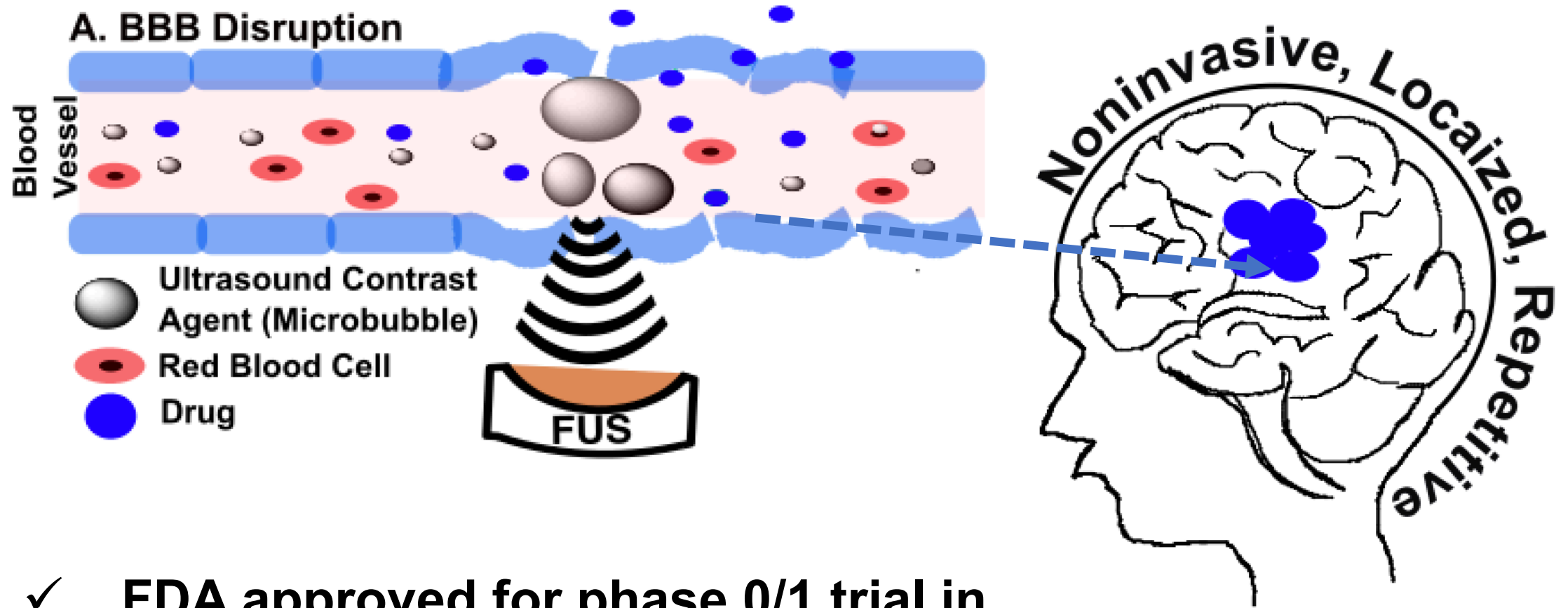
- **Biopharmaceutical**

- **New: Focused Ultrasound**

# Vascular Opening



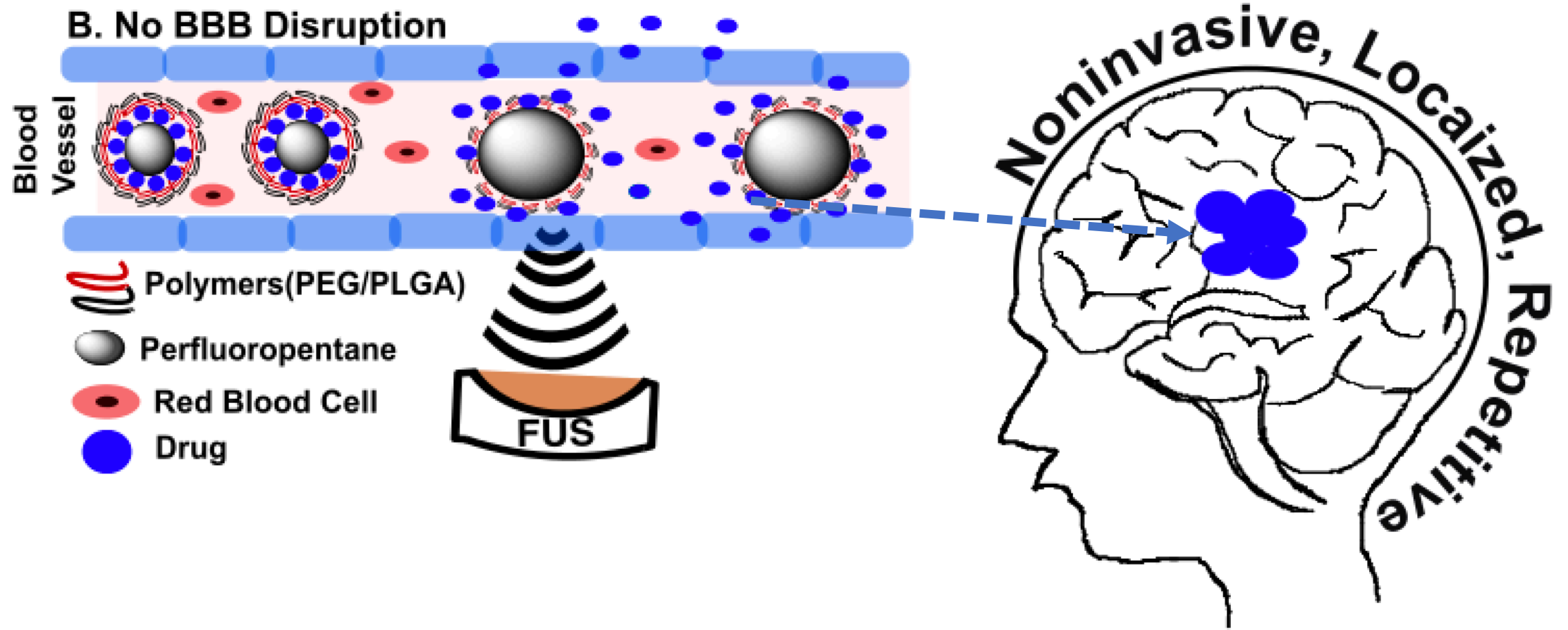
# Vascular Opening



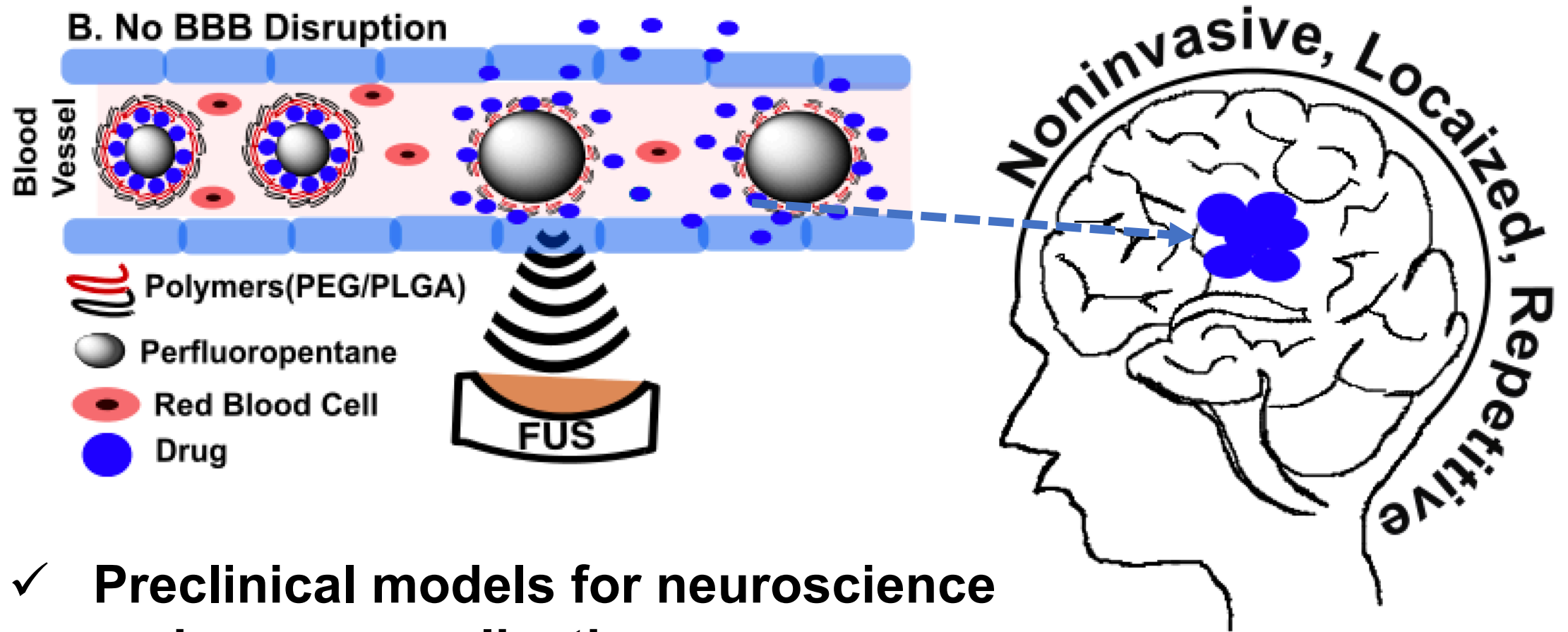
- ✓ **FDA approved for phase 0/1 trial in brain cancer and alzheimer**



# Without Vascular Opening



# Without Vascular Opening

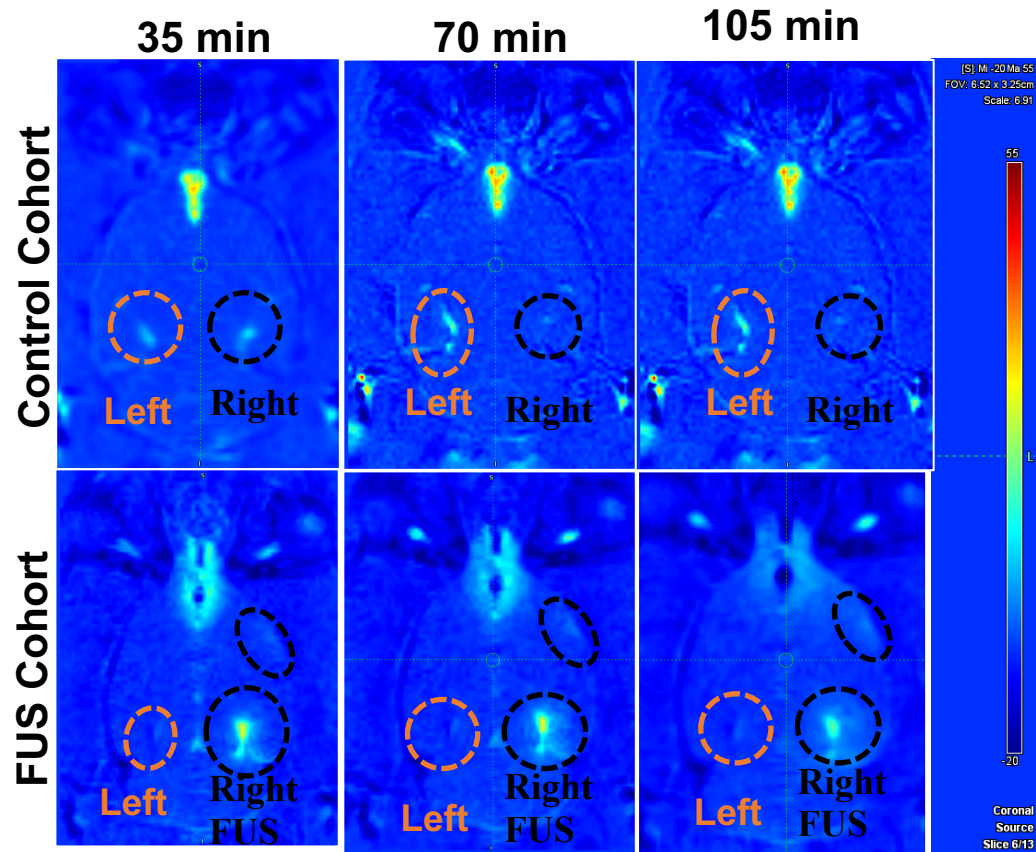


✓ **Preclinical models for neuroscience and cancer applications**

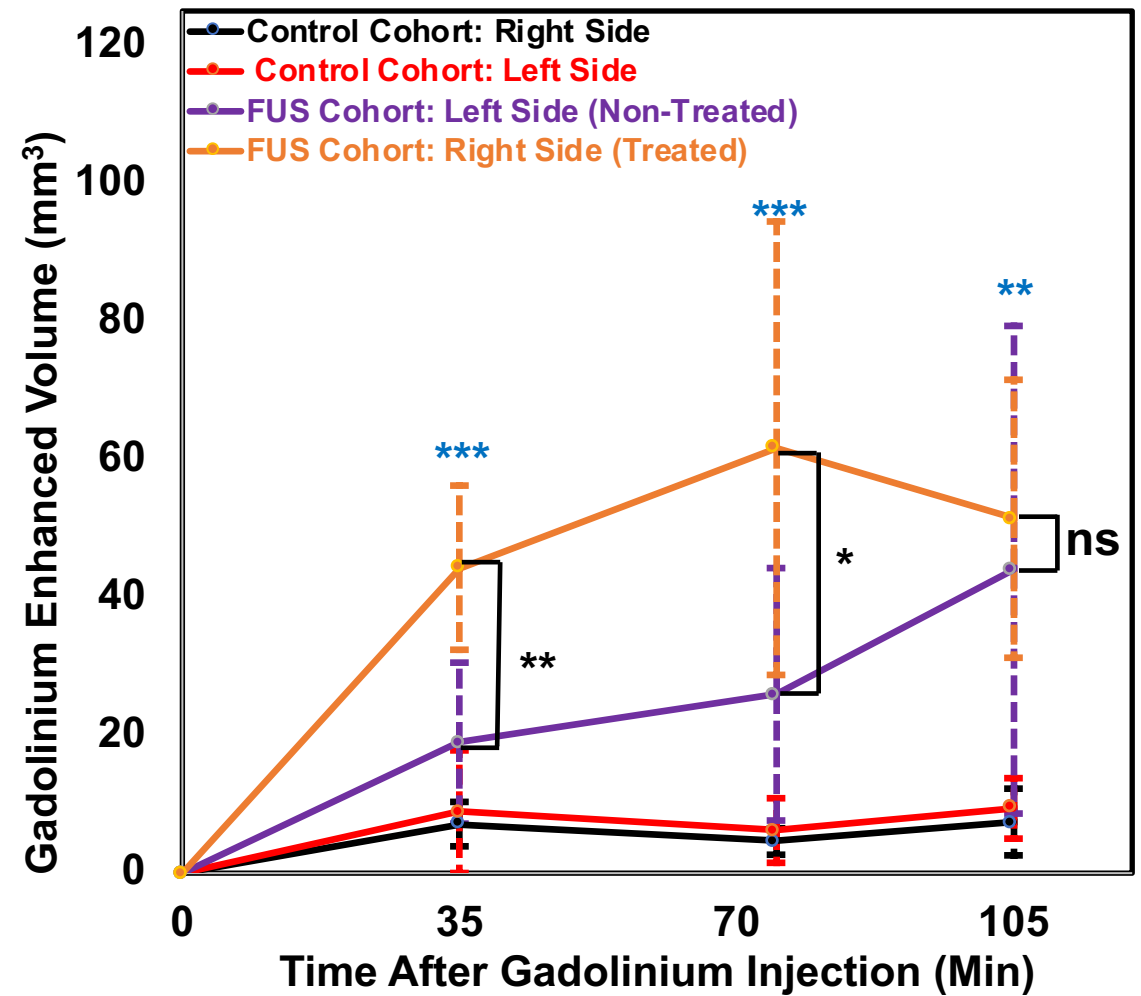
Zhong et al., *Biomaterials*. 2019

Aryal\* & Wang\* et al., *Neuron*. 2018, \* equally contributed

**Stanford University**



Normalized Contrast-Enhanced T1-weighted Magnetic Resonance Images of rat brain



Note: black colored stars & ns: two tailed paired t-test between left (non-treated) and right(treated) hemisphere of the brain in FUS cohorts  
 blue colored stars & ns: two tailed unpaired ttest between Control and FUS Cohort of right hemispheres



# Acknowledgement

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Airan's Lab



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**Thank you**