

# BOLD variability as a biomarker of concussion in college athletes

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## Introduction

Concussion poses a significant public health challenge, with considerable variability in clinical outcomes and neuroimaging results. Traditional studies comparing post-concussion data to healthy controls overlook individual baseline differences, which limits their ability to precisely assess concussion-related changes. By studying individuals before and after concussion, we can control for these baseline factors and obtain a clearer understanding of the effect of the injury.

Recent research suggests that BOLD signal variability may be a more sensitive marker of concussion-related brain alterations than traditional measures. This variability could reflect underlying changes in brain function, such as altered cerebral perfusion or microvascular reactivity, that are not captured by average signal measures. Previous studies have suggested the BOLD signal variability decreases in aging and decreases in variability are associated with worse cognitive performance. Decreases in BOLD variability may also be related to reduced neural complexity and flexibility. We aimed to investigate how concussion affects BOLD variability and its relationship to cognitive deficits.

## Methods

**Participants:** 54 NCAA college athletes

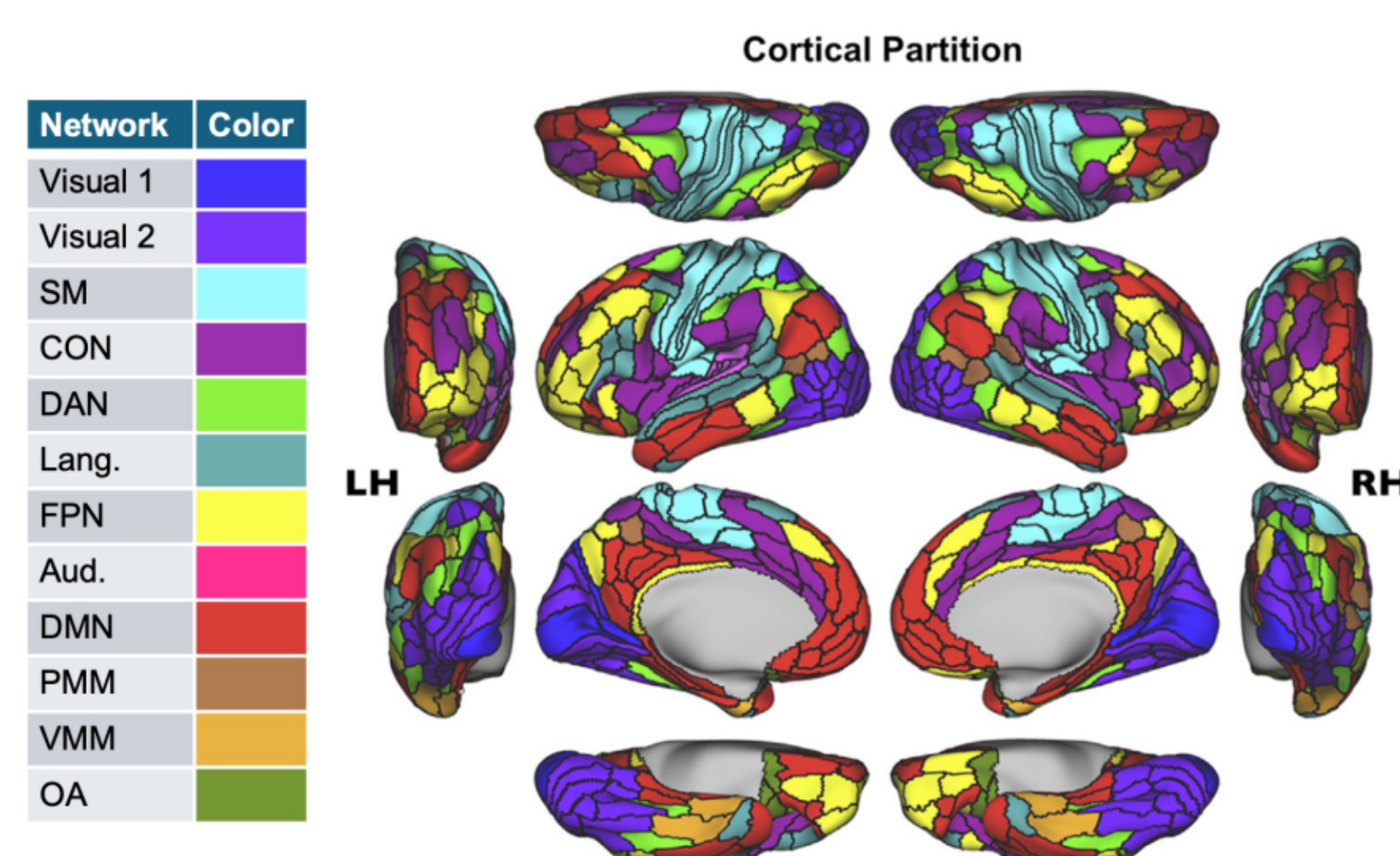
- 48 men (football), 8 women (soccer)
- Mean age = 19.41, SD = 1.55

**Design:**

- Baseline MRI and neurological assessment prior to sport participation
- Post-concussion MRI and neurological assessment ~48 hrs after injury

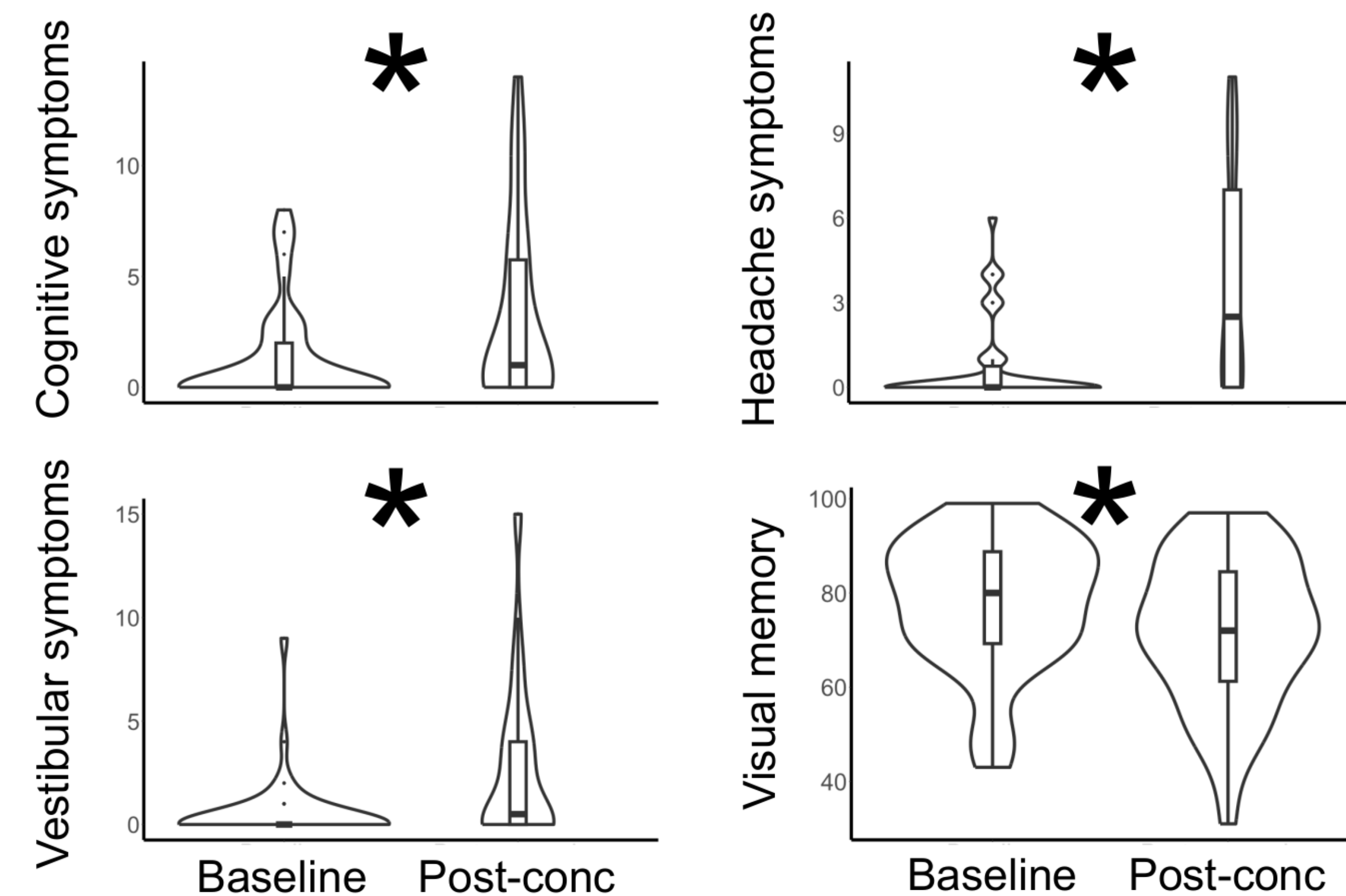
**MRI:**

- Approximately 30 mins of resting-state at each time point
- Standard preprocessing pipeline using ICA-AROMA for denoising
- BOLD variability computed using mean square successive differences at the region, network (see below), and global level

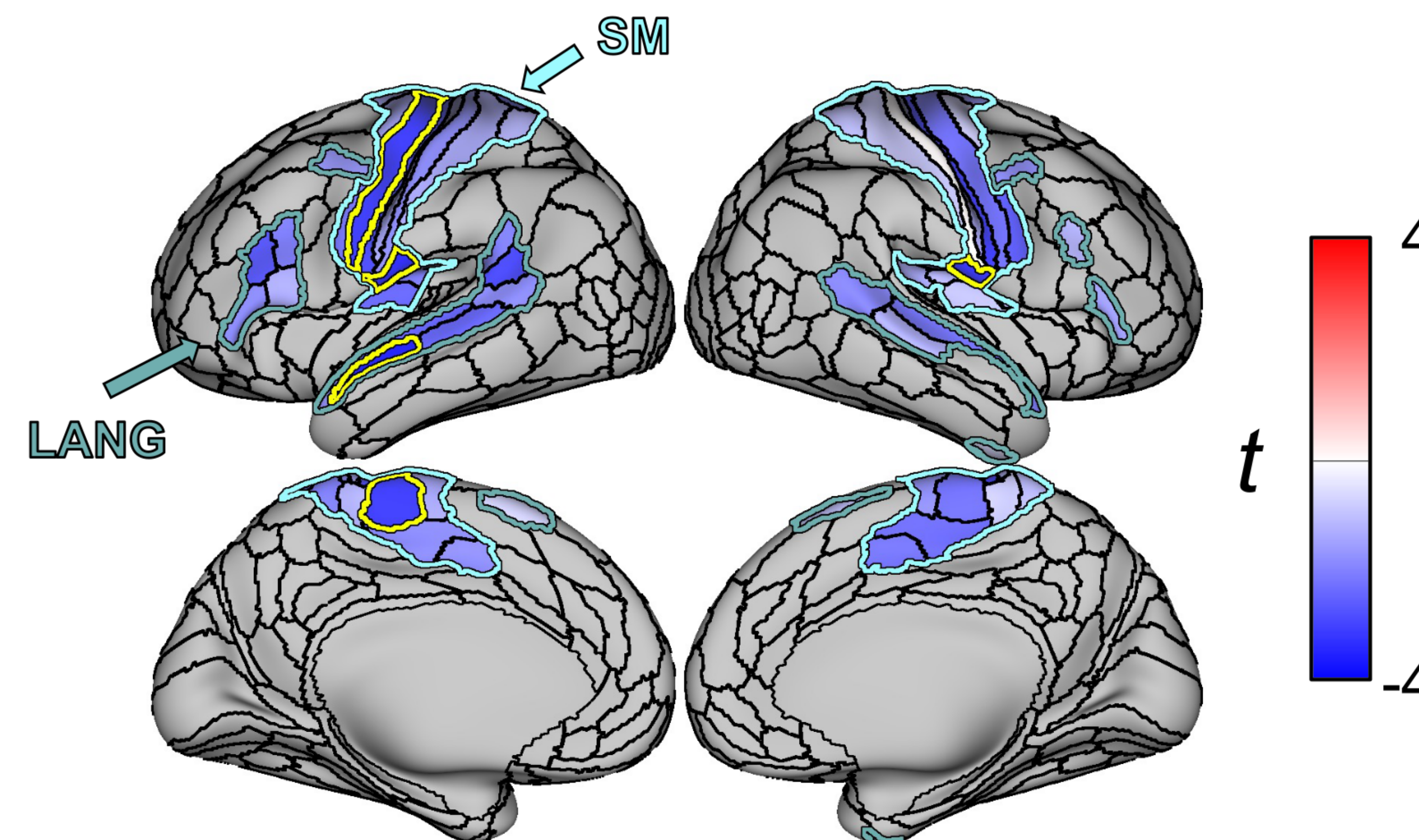


Ji et al., 2019

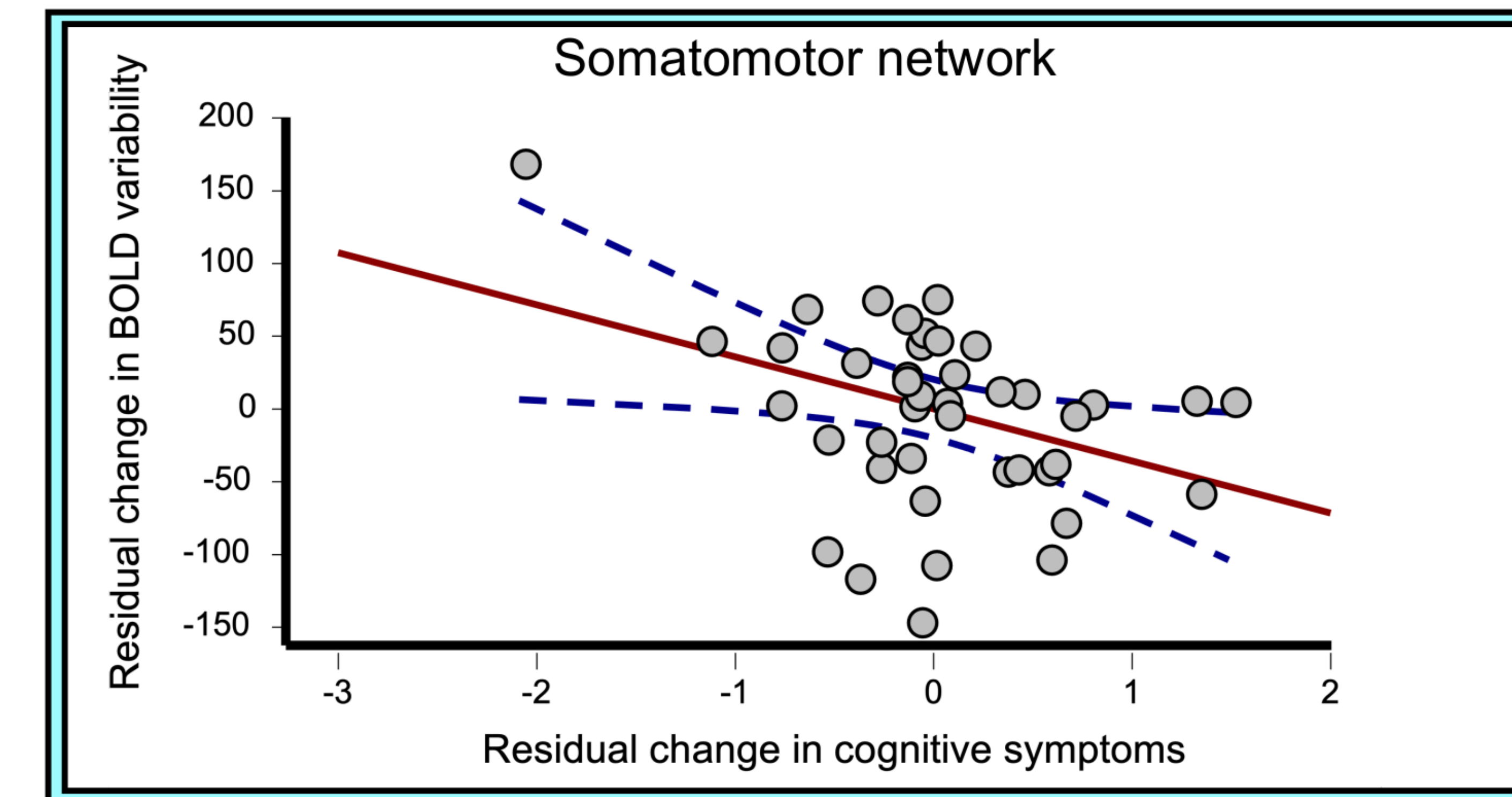
## Increased symptoms and decreased cognitive performance post-concussion



## BOLD variability decreases following concussion in the SM and LANG networks



## Change in variability is related to change in cognitive symptoms



\*Brain-behavior relationship not evident when exclusively examining post-concussion data

## Conclusions

- **BOLD variability decreases from baseline to post-concussion**
  - Consistent with previous work demonstrating decreases in variability related to aging and worse cognitive performance
- **Decreases in variability may result in decreased neural complexity and flexibility which has broad behavioral consequences**
- **Changes in BOLD variability are related to changes in behavior**
  - Considering baseline data strengthens brain-behavior relationships
- **Future work should examine if concussion-related changes in variability are driven by neural, vascular, or neurovascular coupling alterations**

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