# Structural vs. Chemical: Discovering Brain Map Coupling

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## Research Question

Does the physical organization and chemical organization of the brain act as independent modes?

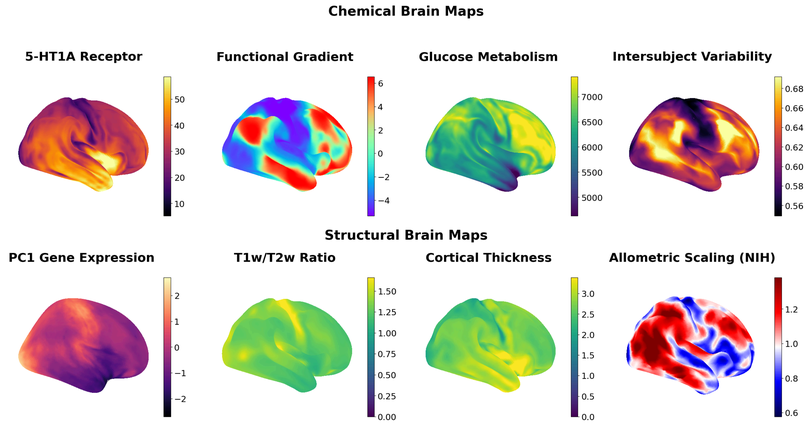



Figure 1: 8 Brain Maps

## Results: Subgroup Analysis

- Maps naturally split into "Structural" and "Chemical" groups. They correlate more strongly within their own group ($\bar{r}$= 0.44) than across the two groups ($\bar{r}$= -0.37)

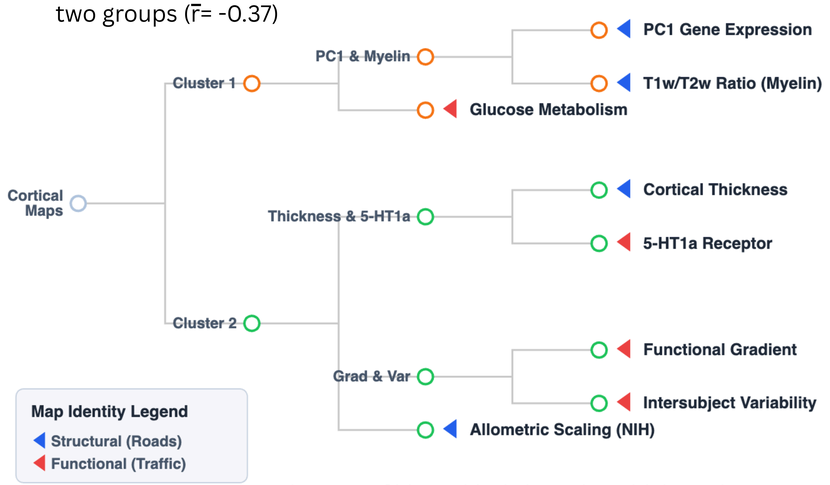



Figure 6: Dendrogram of hierarchical clustering with k = 2 clusters

## Results: PCA

- PCA exhibited two axes explaining ~70% of the total variance: a global coupling axis (PC1: 50.10%) and a structural-functional segregation axis (PC2: 18.08%)

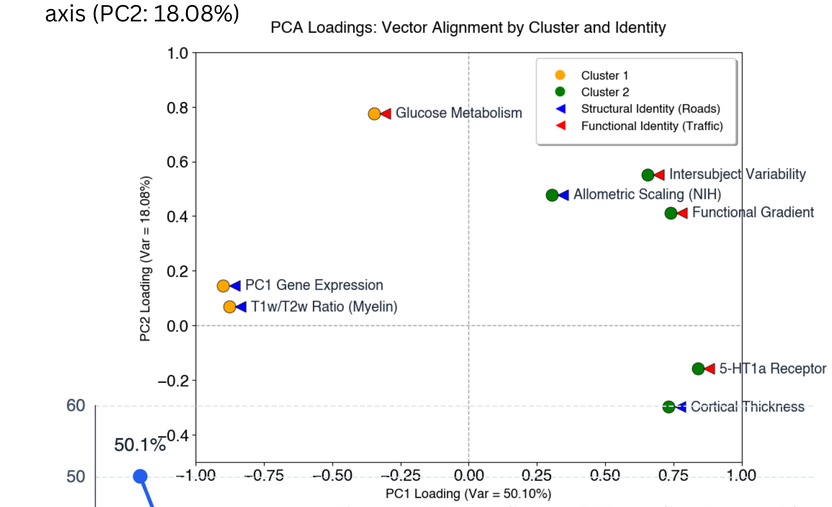



Figure 4: PC1 Loading v.s PC2 Loading Scatter Plot

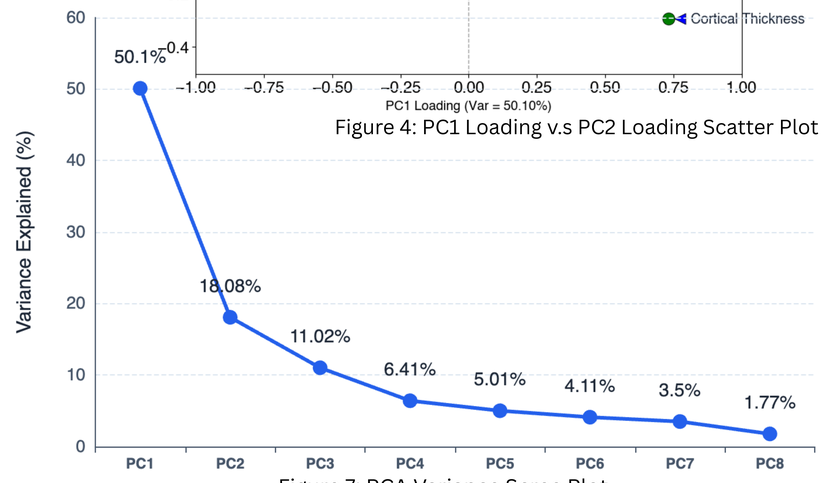
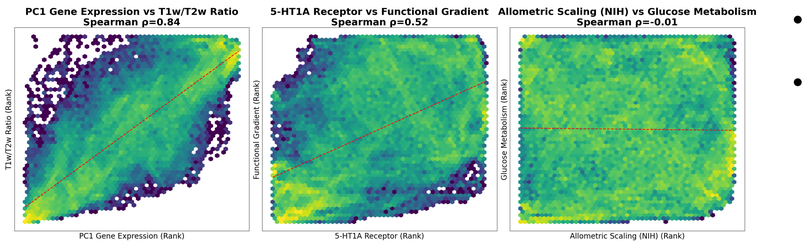



Figure 7: PCA Variance Scree Plot

## Methods



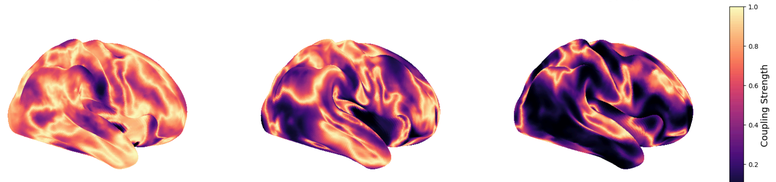
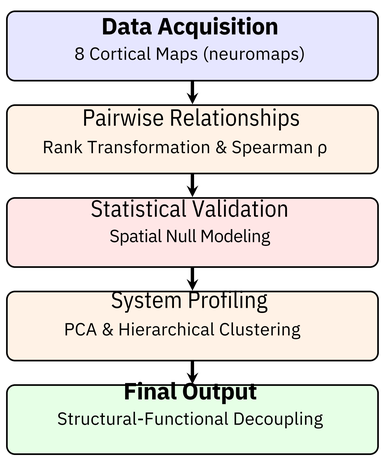




Figure 2: Ranked Pairwise Density Scatter plots & Coupling Brain Maps




- Complex "hockey stick" relationships demonstrating structural & chemical modalities are not globally linked
- Maps are tightly coupled in primary sensory regions but highly uncoupled in the association cortex

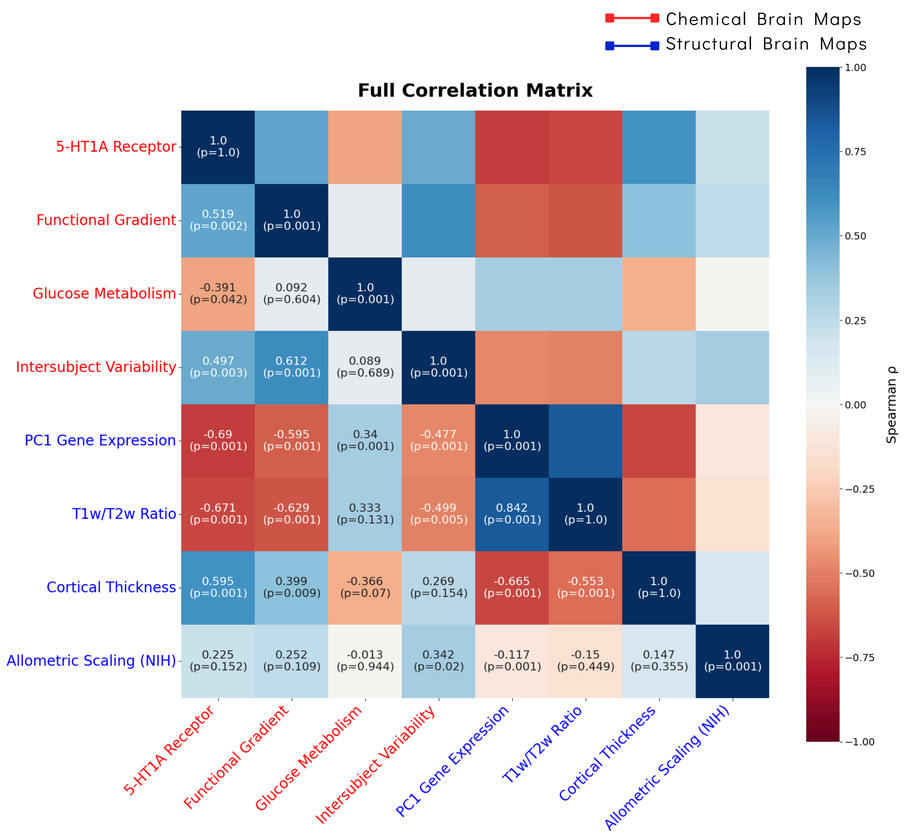



Figure 5: Multimodal Spearman Correlation Matrix

## Summary of Findings

- Maps are tightly coupled in primary sensory regions but highly uncoupled in the association cortex
- The association cortex uncouples from rigid structural gradients to allow for abstract reasoning and complex decision making
- Two dominant semi-independent clusters: a foundational/structural system (driven by genes and myelin) and a higher-order/functional system (driven by functional gradients and receptor distributions)

## Next Steps

- Explore additional modalities & multimodal coupling trends across development and aging in patients
- Explore the relationship with neurodegenerative pathologies or psychiatric studies

## References

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