

# Characterizing schizophrenia neural dynamics using univariate time-series feature analysis

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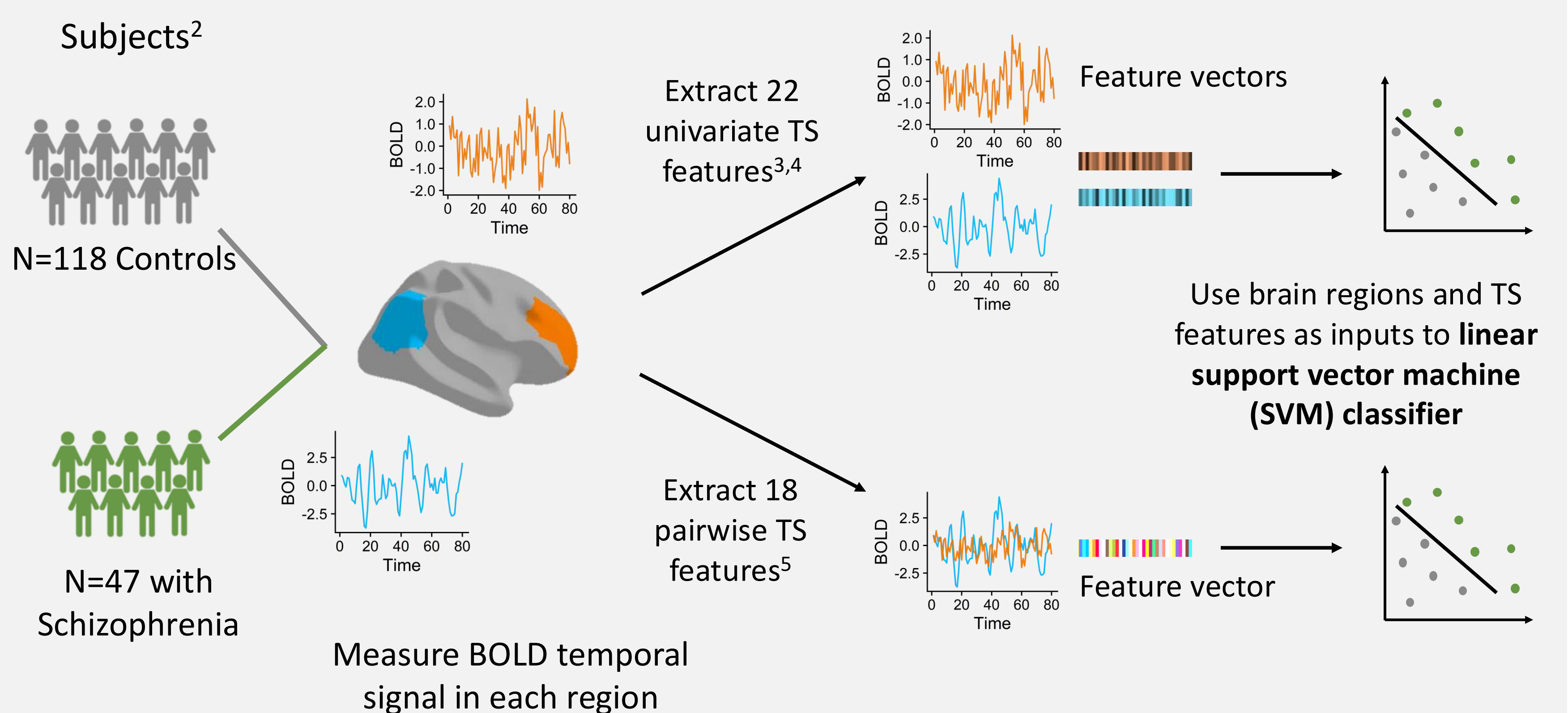
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## Background

Functional magnetic resonance imaging (fMRI) is often used to interrogate **differential neural activity** in diverse neurological diseases like **schizophrenia**. Blood oxygen level dependent (BOLD) fMRI time-series data can be combined with graph-based **functional connectivity metrics** and/or **machine learning methods** to classify patients from controls with high accuracy<sup>1</sup>. However, such approaches generally **miss region-specific local dynamics** and **lack biologically interpretable insights** due to their black-box nature.

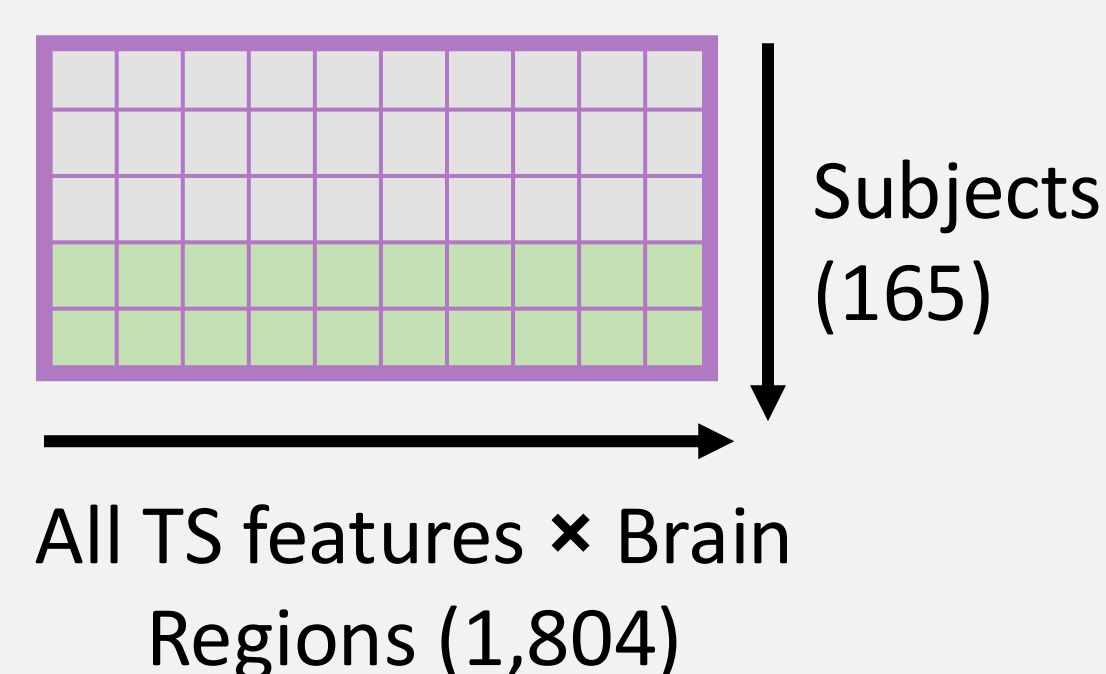
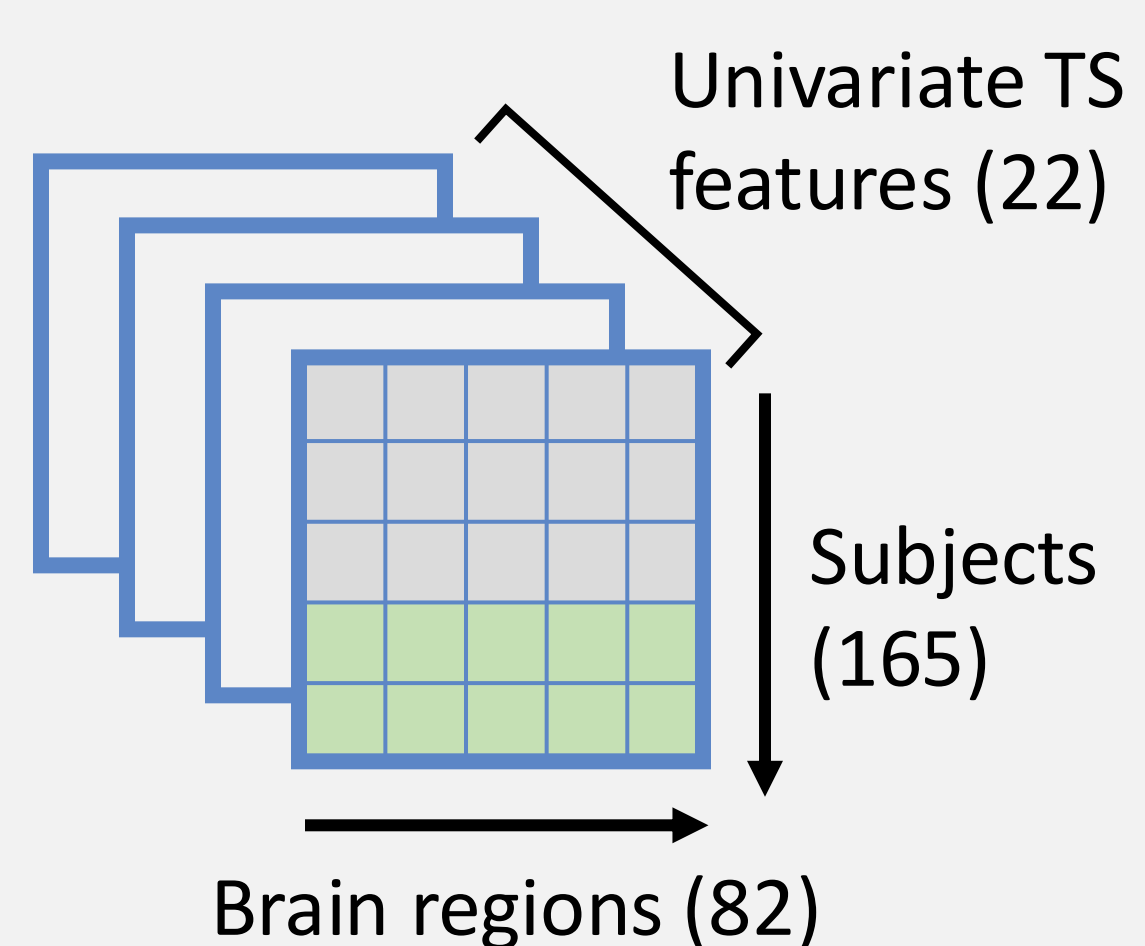
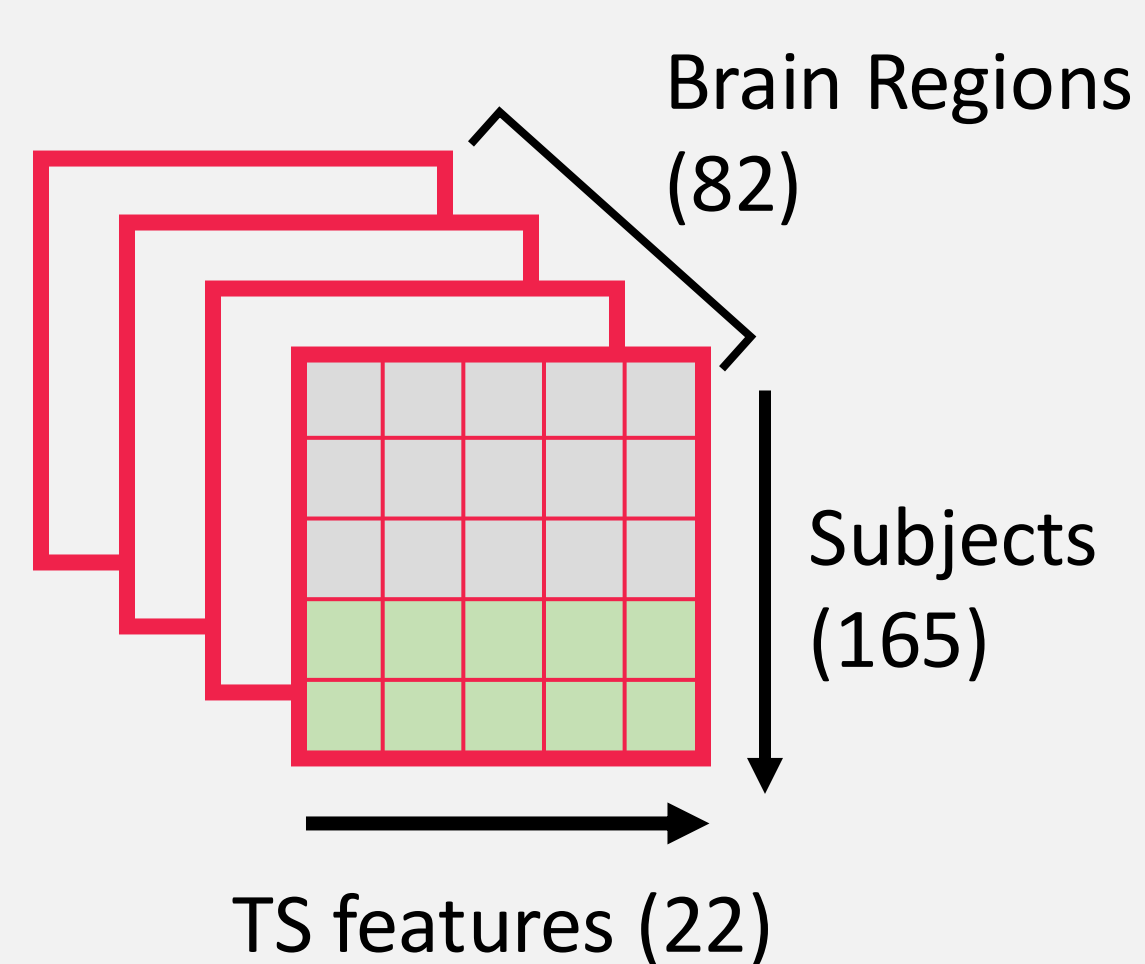
Here, we present the first comprehensive analysis of **univariate and pairwise time-series (TS) features** derived from **fMRI** signals in the brains of participants with and without **schizophrenia**. Using a simple linear support vector machine classifier, we demonstrate the benefit of integrating **local and pairwise temporal properties** to elucidate underlying **differences in regional neural activity** in schizophrenia.

## Methods: Extracting TS Features from BOLD fMRI

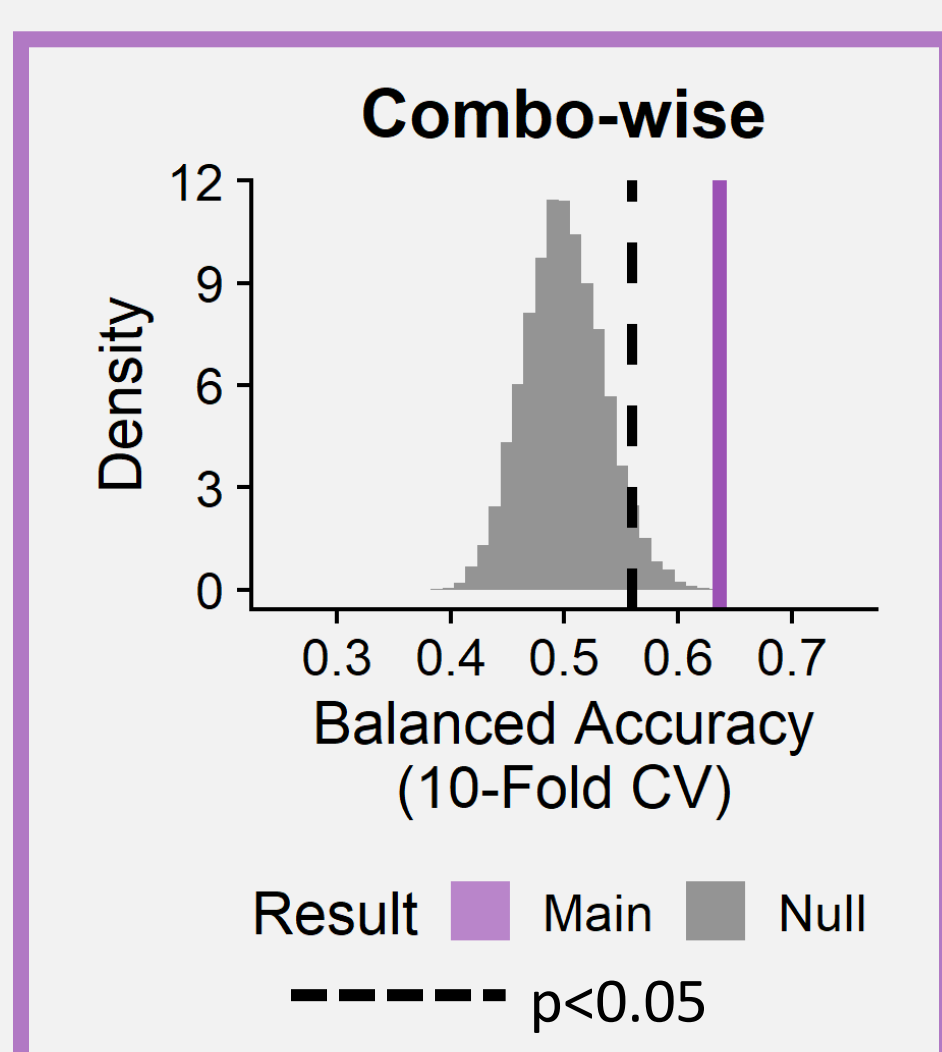
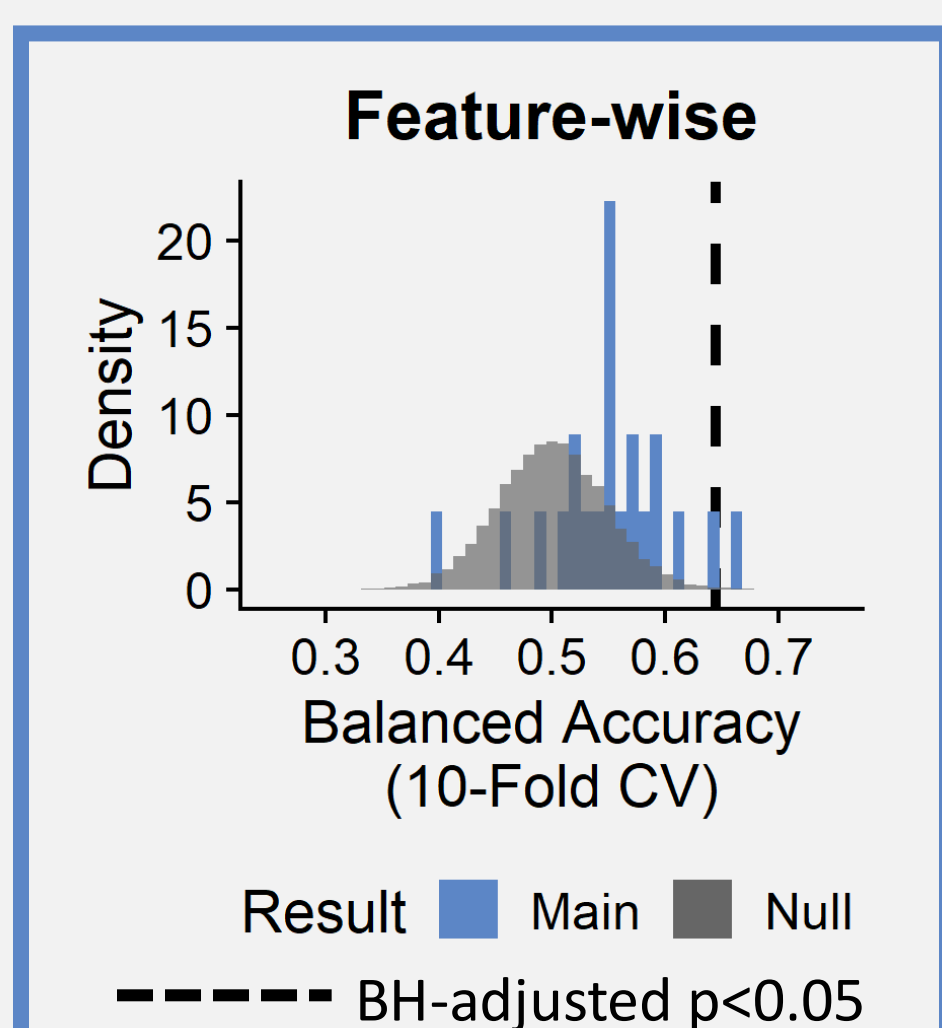
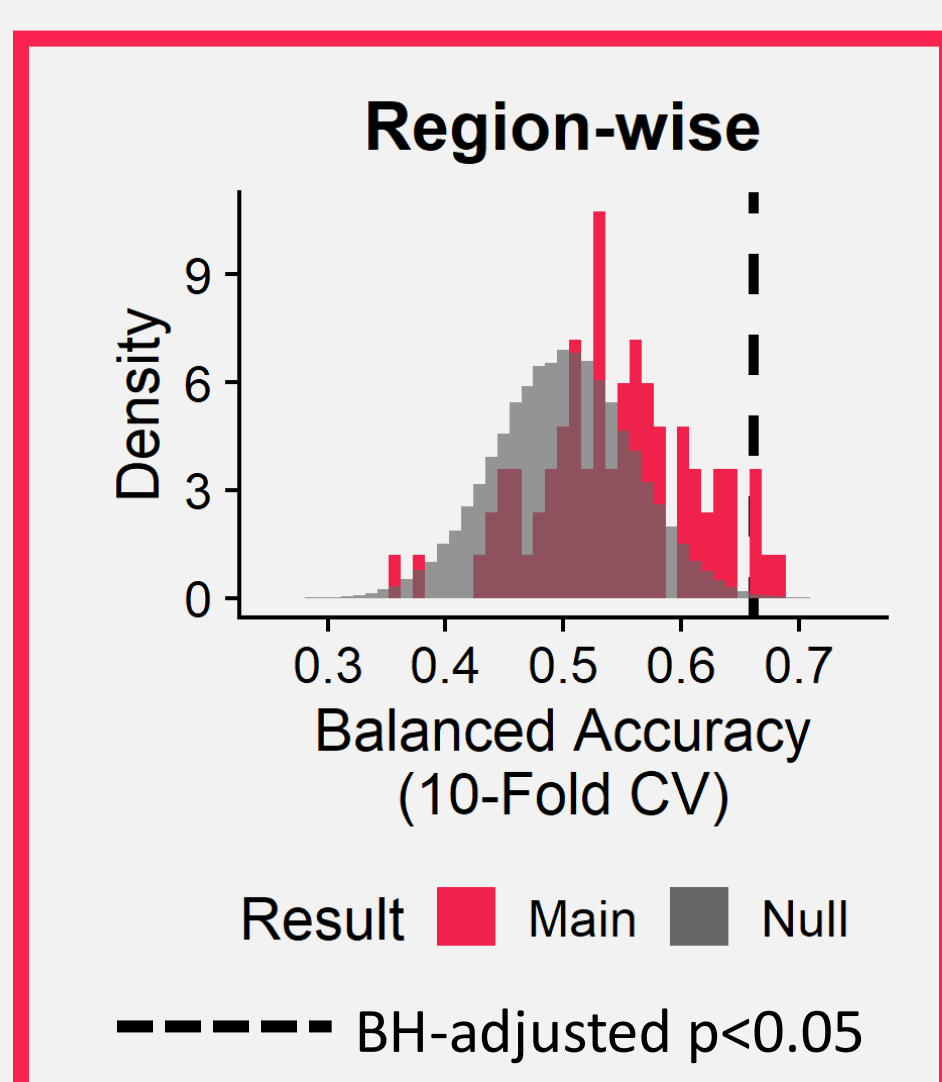


## Results

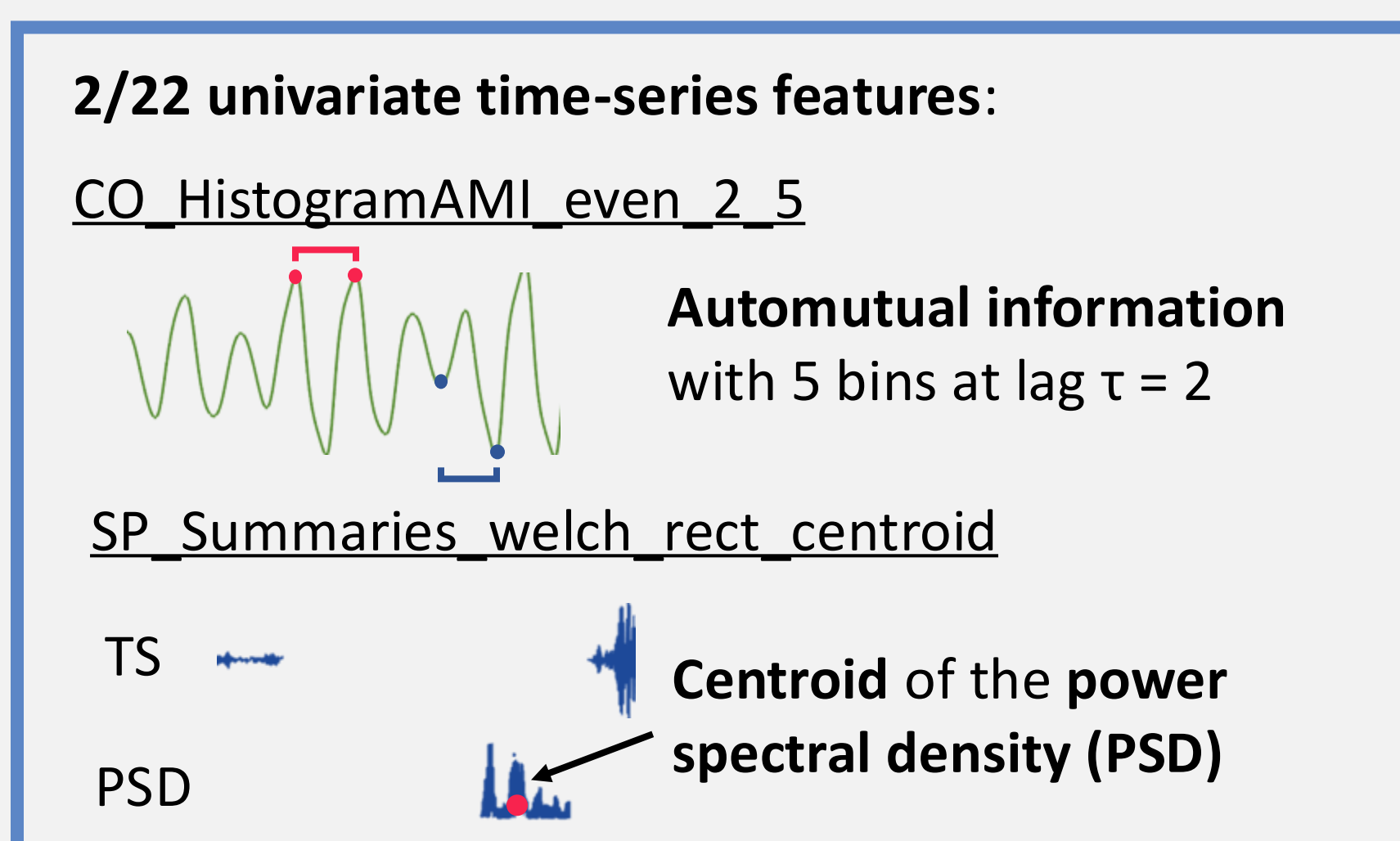
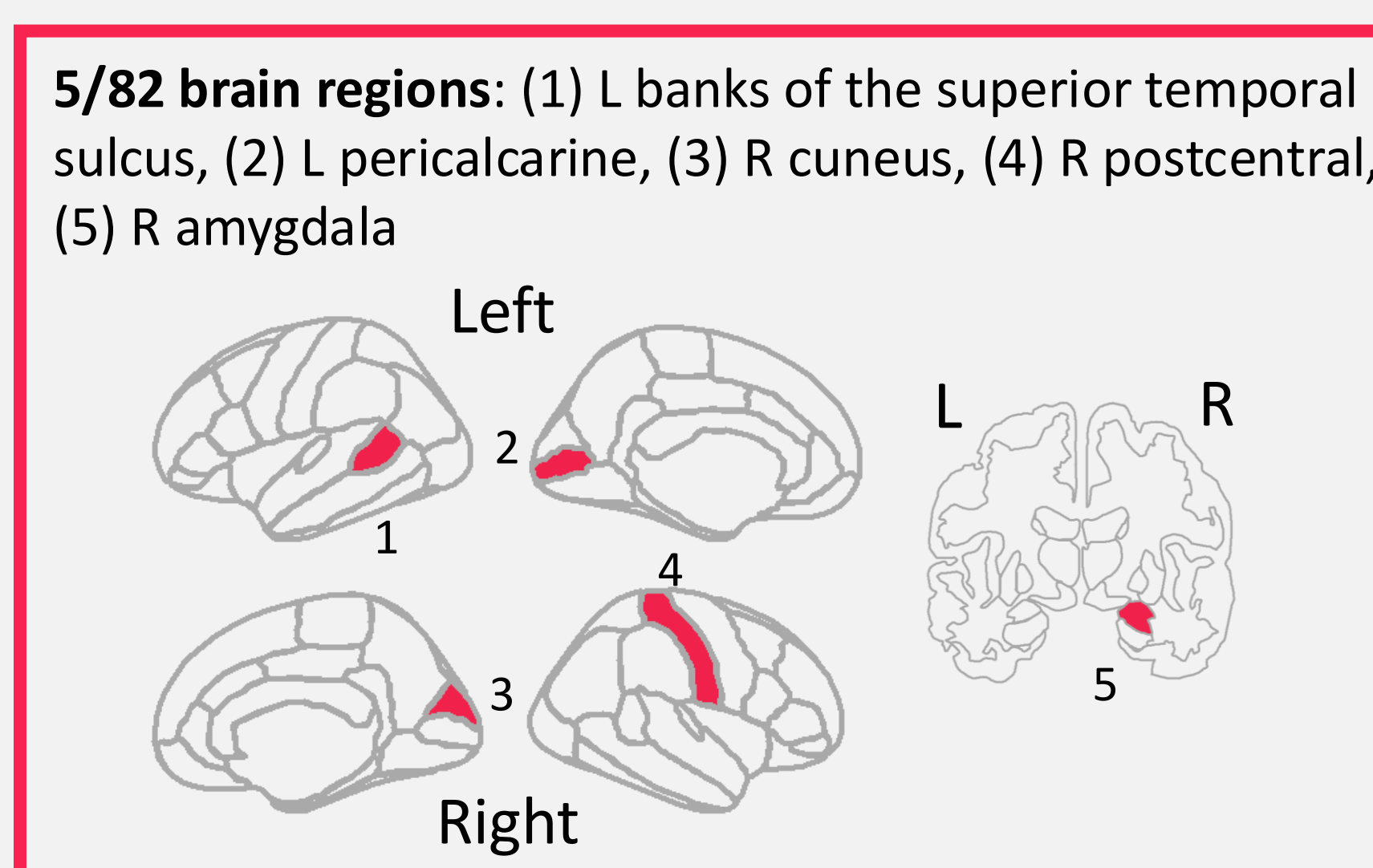
Data is partitioned for linear support vector machine (SVM)



Balanced accuracies are compared against null model distributions

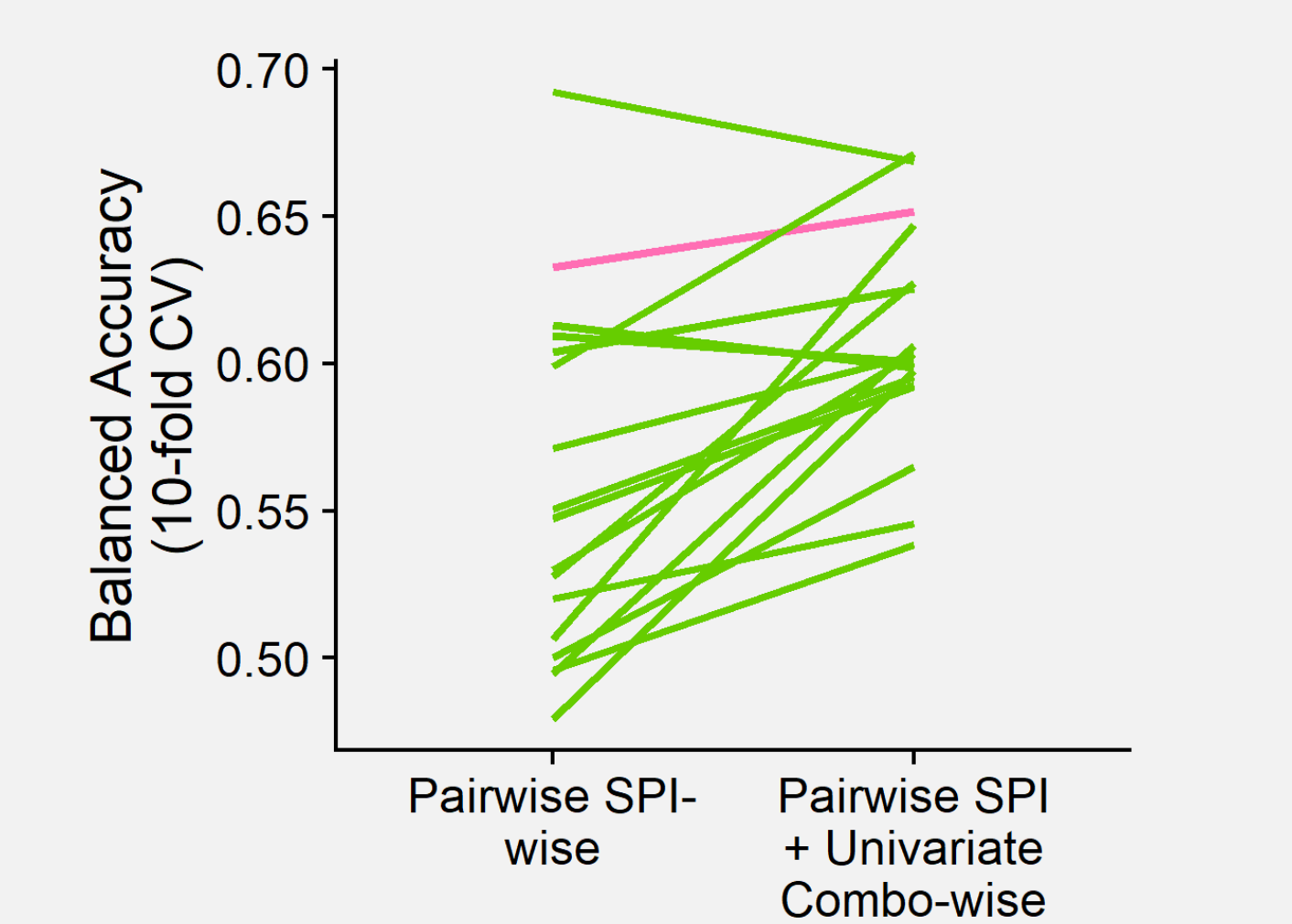
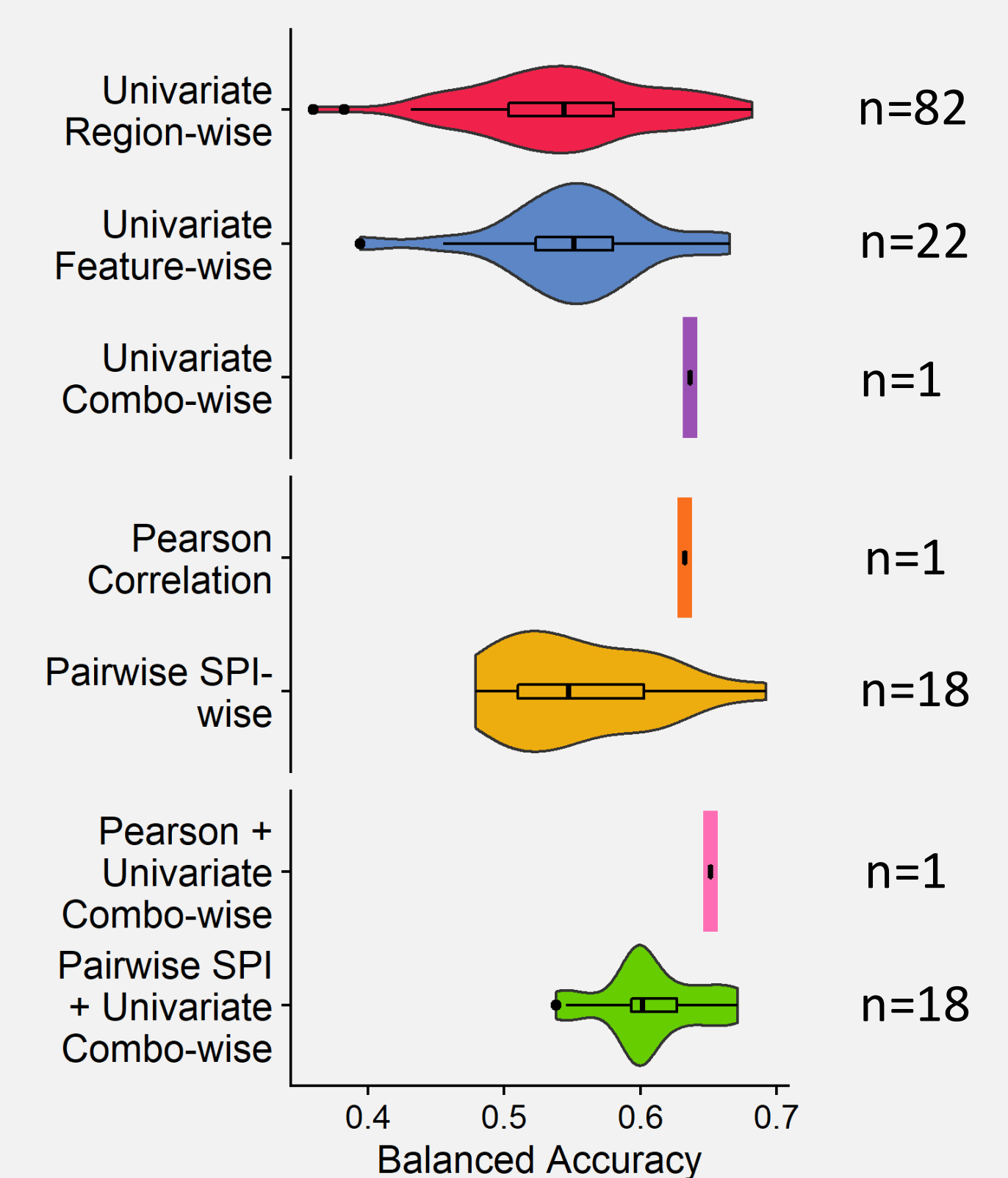


Brain regions and TS features show significant classification results



The combination of **all brain regions x TS features** as inputs to linear SVM classifier yields a statistically significant balanced accuracy of **64%** ( $p \approx 1 \times 10^{-5}$ ).

Including univariate TS features improves pairwise classification performance



Linear SVM with each **statistical pairwise interaction (SPI)** with or without the addition of **univariate combo-wise data**, shows that adding the univariate region-by-feature data **generally improves balanced accuracy** (mean +5%).

## Conclusions

This analysis highlighted both **individual brain regions** and **univariate TS features** derived from BOLD fMRI that distinguish participants with versus without schizophrenia. **Pairwise TS features**, like the commonly-used Pearson correlation coefficient, showed **improved linear SVM classification performance** with the **inclusion of univariate TS feature information**.

## Key Takeaways

Systematically quantifying **univariate TS features** presents a promising method for understanding how the **dynamics of individual brain regions** contribute to **disrupted network activity** in neurological disease.

## Selected References

1. Quaak M et al. *NeuroImage Clin* (2021)
2. Gorgolewski KJ et al. A Preprocessed consortium for Neuropsychiatric Phenomics dataset. (2017)
3. Henderson T and Fulcher BD. *ICDMW* (2021)
4. Lubba CH et al. *Data Min Knowl Discov* (2019)
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## Acknowledgements

This work was supported by The University of Sydney Physics Foundation and the American Australian Association Graduate Education Fund.

