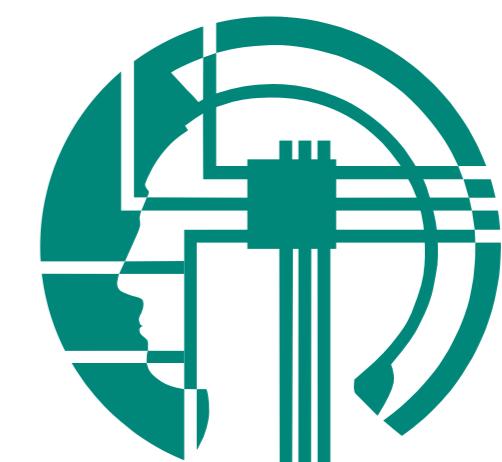


# Riemannian Geometry for fNIRS-BCIs and other clinical applications

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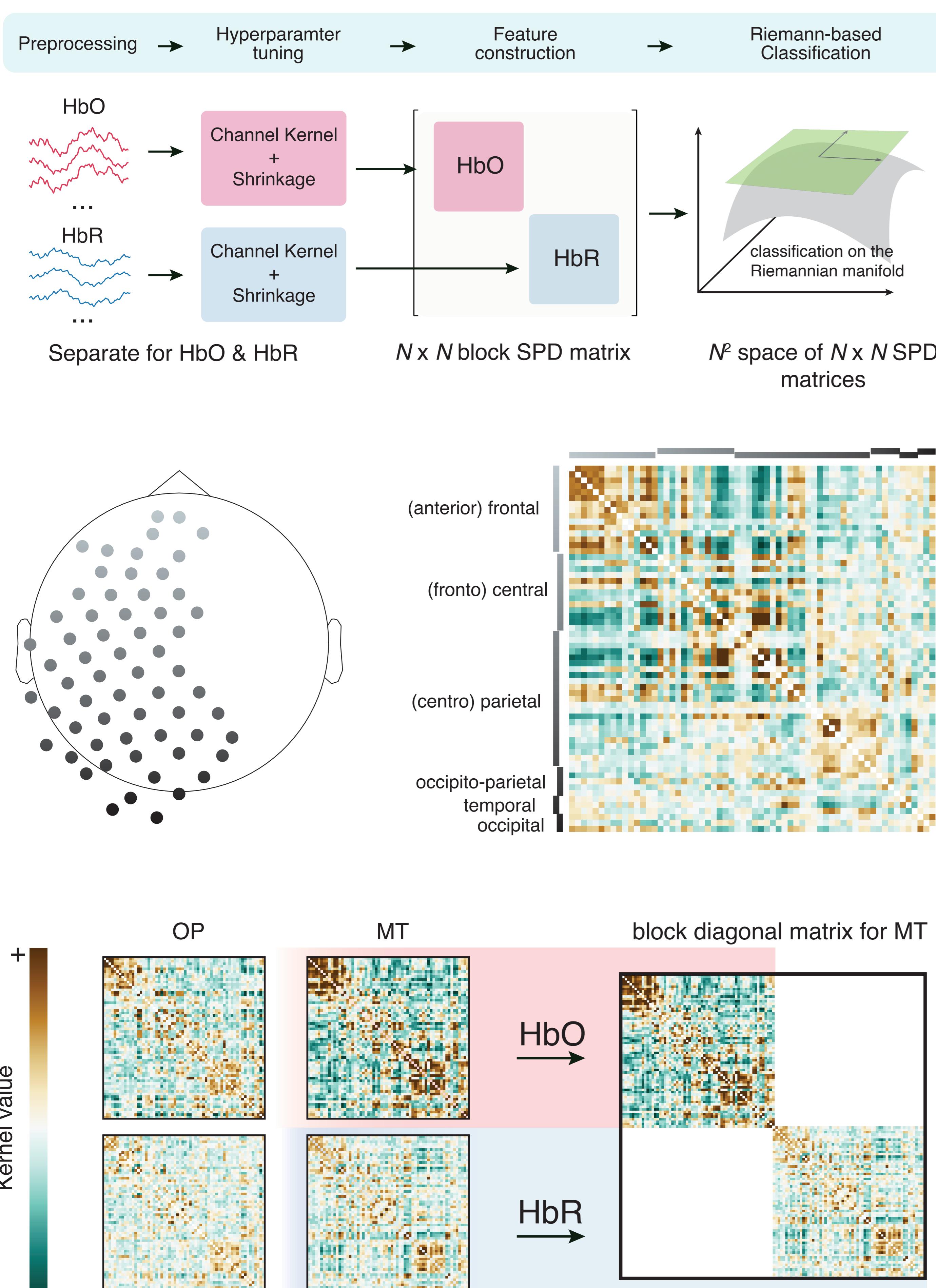
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## INTRODUCTION

Functional near-infrared spectroscopy (fNIRS) has become a popular tool for brain-state assessment due to its portability, non-invasive nature, and resilience to movement<sup>1,2,3</sup>. However, compared to functional magnetic resonance imaging (fMRI), fNIRS has limitations in terms of brain coverage and sensitivity to deeper brain activity. Additionally, advancements in fNIRS-based classification methods have not received as much attention as in fMRI, resulting in limited performances. In this study, we present a classification approach leveraging Riemannian geometry to enhance the accuracy of brain-state classification with eight different mental-imagery tasks. We also successfully applied this framework to a proof-of-concept clinical command-following paradigm aimed at diagnosing remaining awareness in patients with disorders of consciousness (DoC).

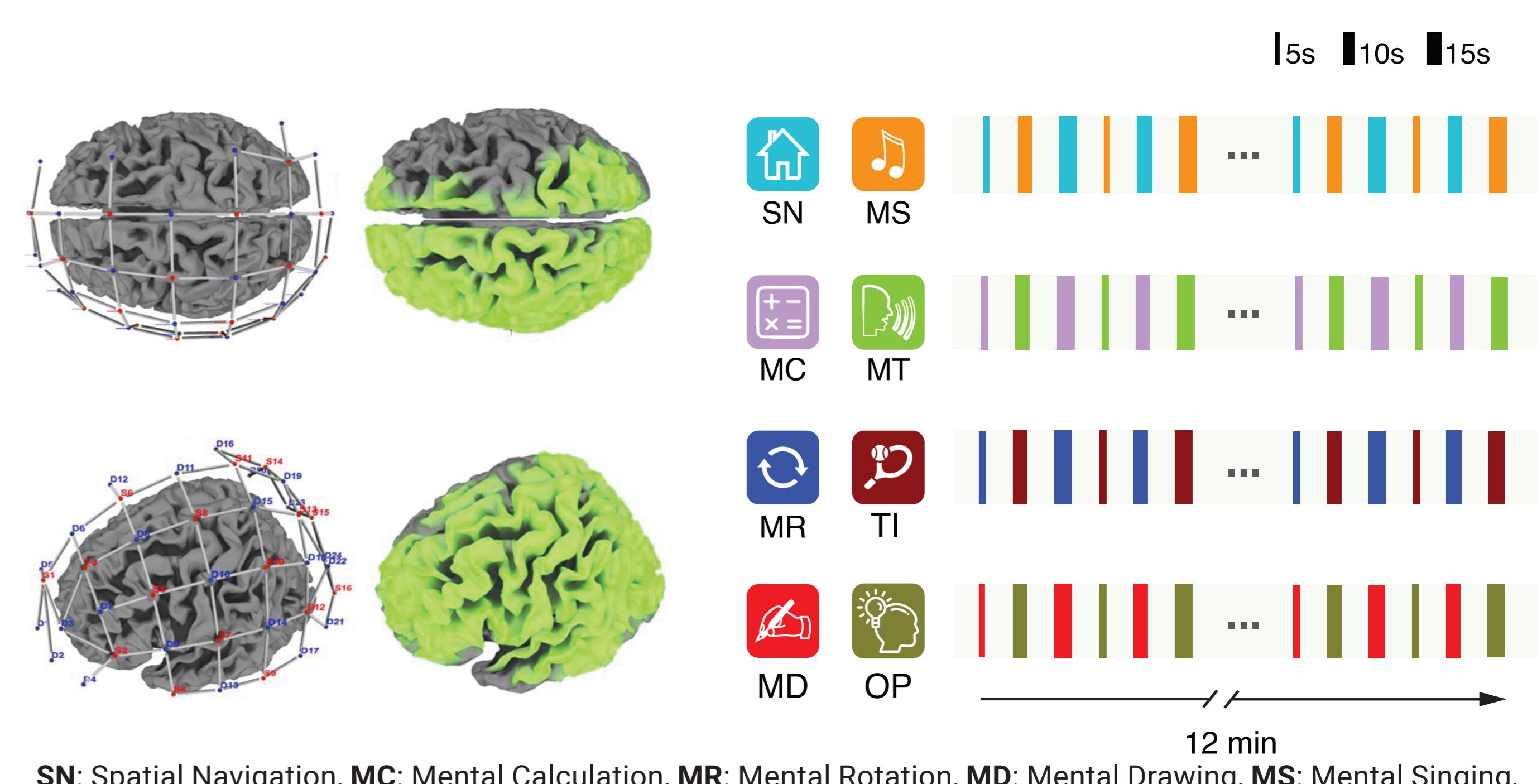
## MODEL & KERNEL MATRICES



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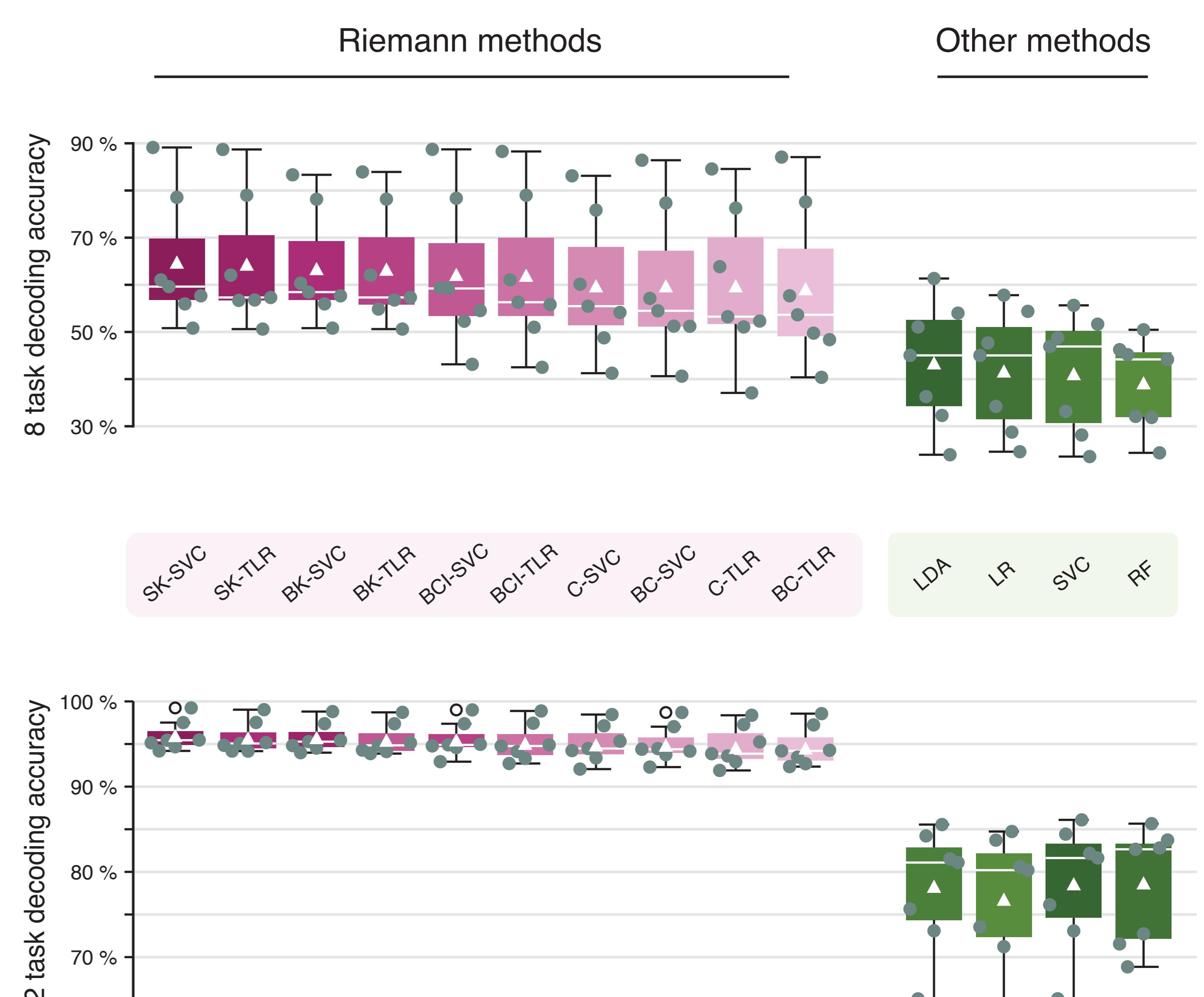


## EXPERIMENTAL PARADIGM

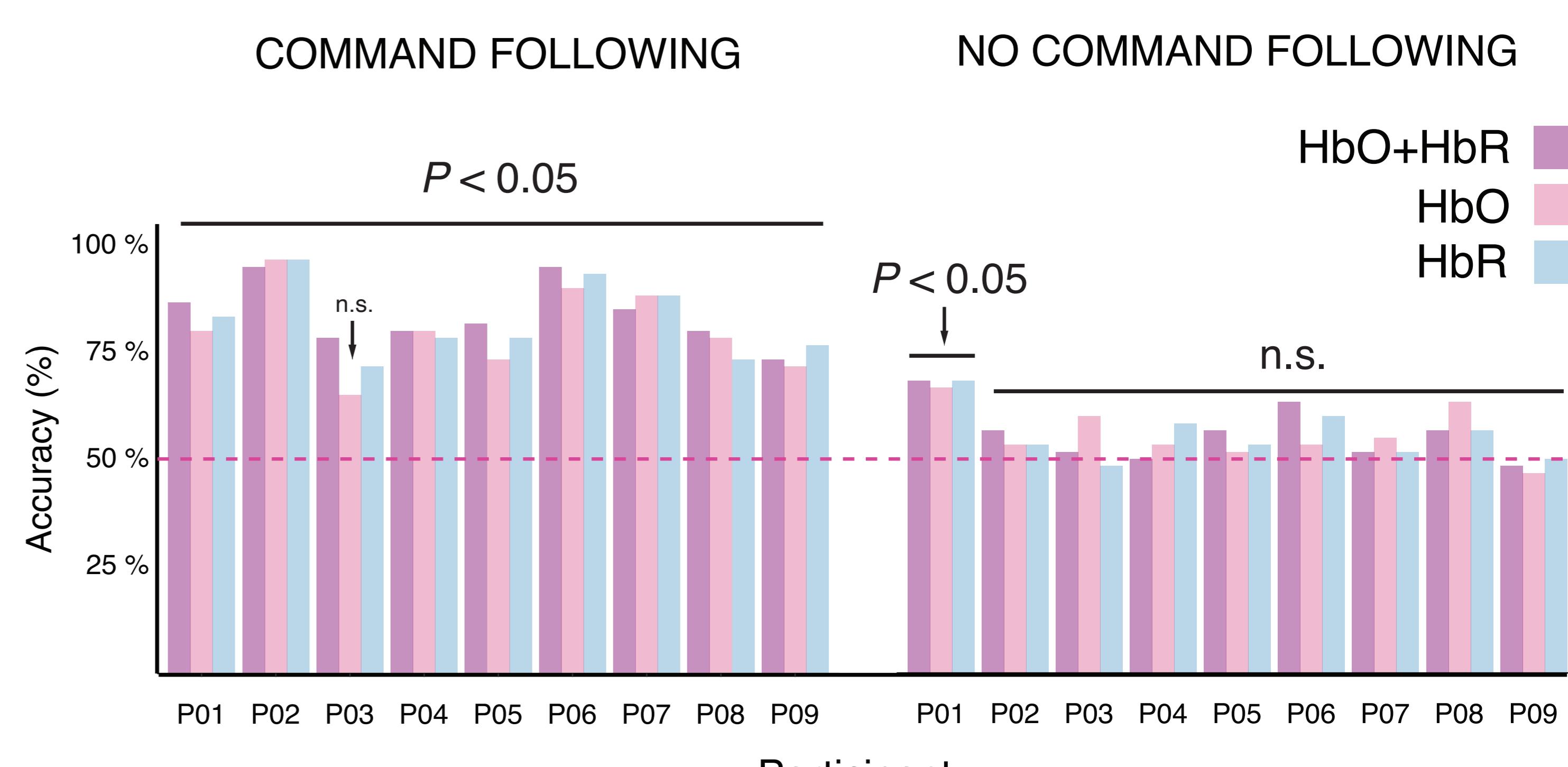


SN: Spatial Navigation, MC: Mental Calculation, MR: Mental Rotation, MD: Mental Drawing, MS: Mental Singing, MT: Mental Talking, TI: Tennis Imagery, OP: Own Mental Paradigm

## CLASSIFICATION RESULTS



## CLINICAL APPLICATION



## References

- 1 F. Klein, S. H. Kohl, M. Lührs, et al., "From Lab to Life: Challenges and Perspectives of fNIRS for Hemodynamic Neurofeedback in Real-World Environments," (2023)
- 2 S. H. Kohl, D. M. A. Mehler, M. Lührs, et al., "The Potential of Functional Near-Infrared Spectroscopy-Based Neurofeedback—A Systematic Review and Recommendations for Best Practice," *Frontiers in Neuroscience* 14, 594 (2020)
- 3 S. R. Soekadar, S. H. Kohl, M. Mihara, et al., "Optical brain imaging and its application to neurofeedback," *NeuroImage: Clinical* 30, 102577 (2021).