Exploring Resting State fMRI & Functional Connectivity Patterns in Chronic Pain

THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

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Abstract

Facial pain disorders pose a considerable health challenge, yet their neural mechanisms remain elusive. This study seeks to illuminate disparities in brain connectivity patterns between healthy controls and individuals afflicted with facial pain, leveraging resting-state functional magnetic resonance imaging (fMRI) data. The dataset, comprising 20 rs-fMRI healthy controls data and 56 chronic pain arthritis participants' data collected across two phases of a chronic pain study, was sourced from the OpenfMRI database with accession number ds000208. Pre-processed fMRI data from both cohorts were aligned to a common brain template for group-level comparisons. Employing Seed-based Correlation Analysis (SCA), we explored functional connectivity patterns among 64 regions of interest (ROIs) implicated in pain processing, as delineated by the Automated Anatomical Labeling (AAL) atlas, spanning the voxel space (64x116). Subsequently, a thorough statistical examination was conducted, employing a two-sample t-test with 10,000 bootstraps to ensure the robustness and reliability of our findings. To counteract the risk of false positives, we applied false discovery rate (FDR) correction. Our results reveal substantial alterations in brain connectivity networks associated with facial pain, shedding light on the intricate neural mechanisms underpinning this debilitating condition. These insights not only deepen our comprehension of facial pain pathophysiology but also hold promise for the development of targeted therapeutic interventions aimed at alleviating the suffering of affected individuals.

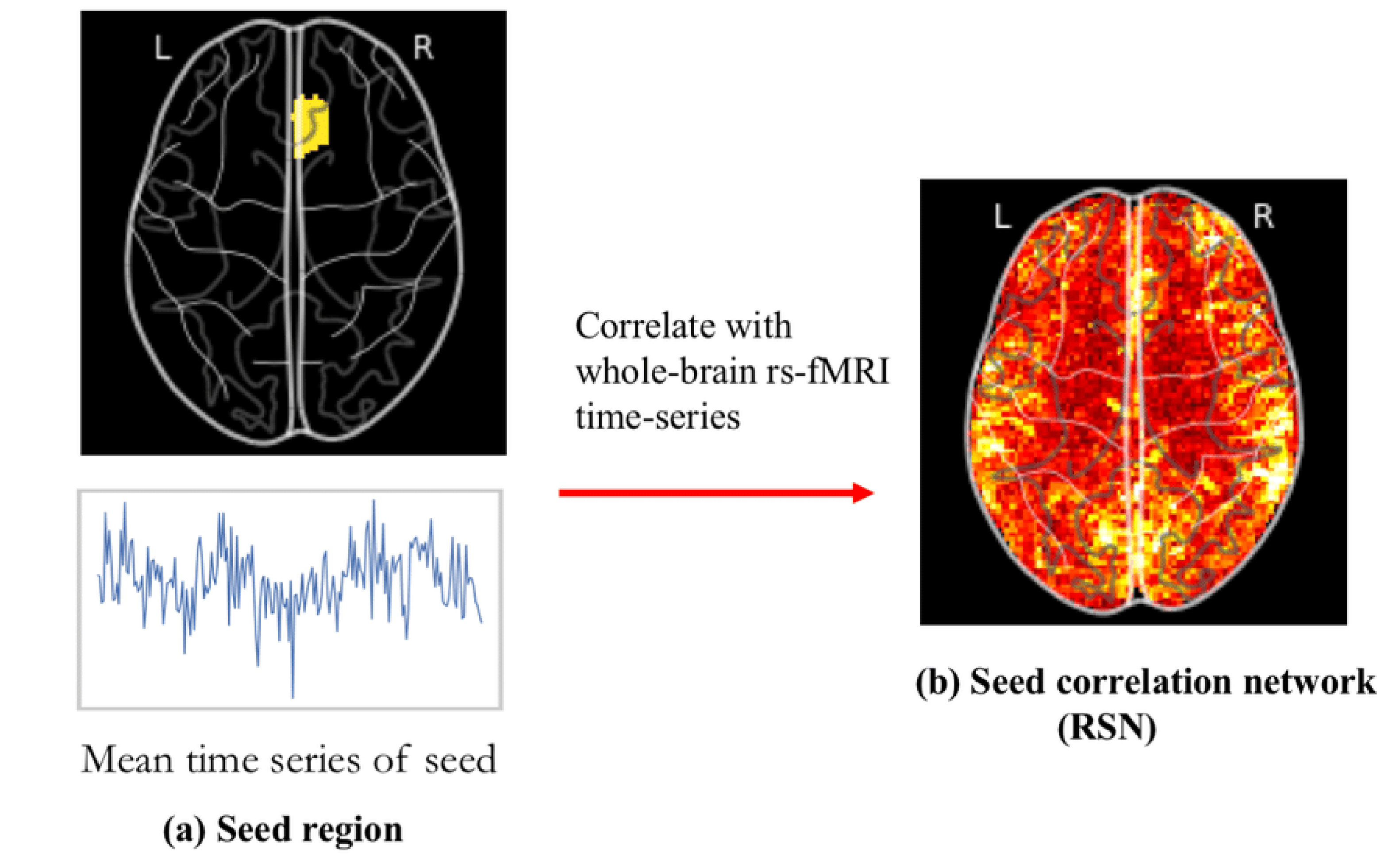

Fig. 2 – Seed based correlation to whole brain rs-fMRI time-series

Background

Facial pain disorders present significant challenges for patients and clinicians, yet our understanding of their neural underpinnings remains incomplete. Functional neuroimaging techniques, particularly fMRI, offer non-invasive insights into the brain's response to pain. While previous studies have shed light on chronic pain conditions, research specifically focusing on facial pain is limited. This gap in knowledge is critical given the diverse etiologies and clinical manifestations of facial pain[1,2]. Understanding its neural correlates can inform improved diagnostic and therapeutic strategies, addressing a pressing clinical need.

A deeper understanding of facial pain's neural mechanisms holds promise for personalized diagnostics and targeted interventions. By elucidating the brain regions and circuits involved in facial pain processing, researchers may identify novel therapeutic targets. This could lead to the development of more effective treatments, ultimately improving outcomes and quality of life for individuals with facial pain disorders.

Objectives

1. Identify alterations in brain connectivity patterns in facial pain patients compared to healthy controls.
2. Compare the connectivity pattern of brain regions involved in pain with the connectivity patters of the same regions in healthy controls.
3. Conduct rigorous statistical analysis with correction for multiple comparisons to ensure reliability and replicability.
4. Contribute to the understanding of the neurobiology of facial pain through robust findings.

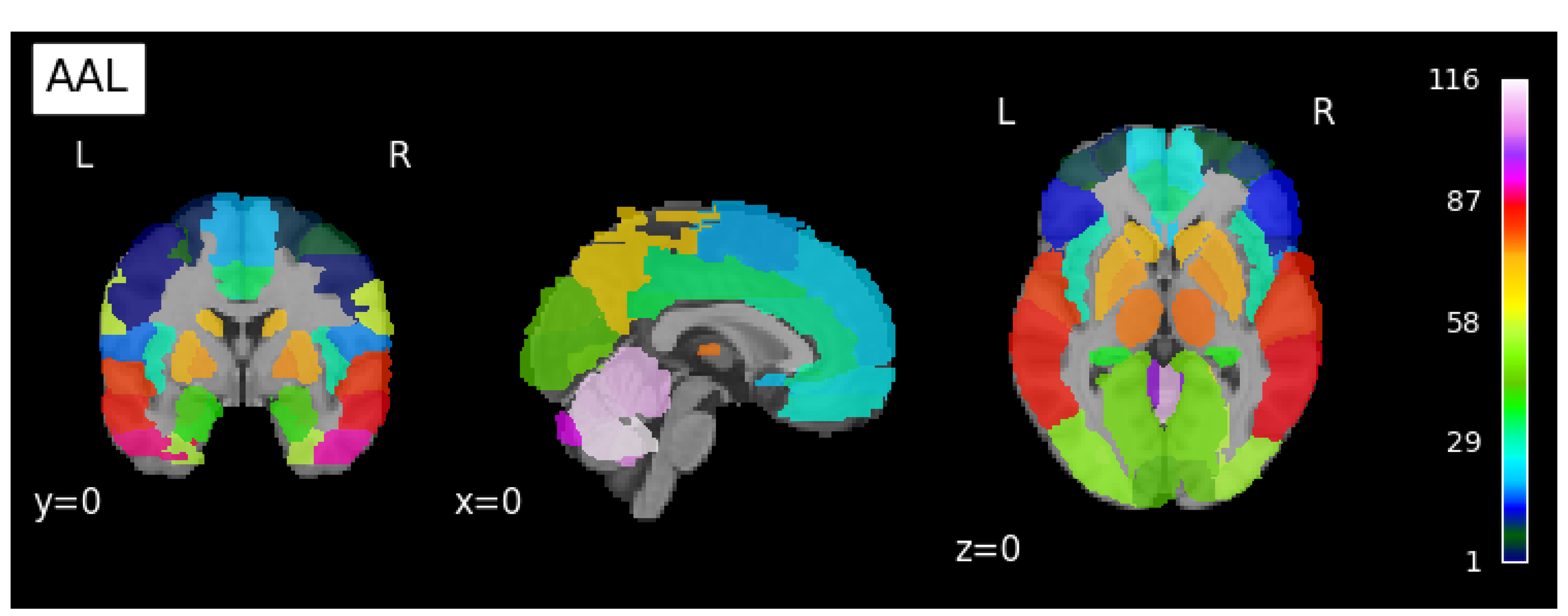

Fig. 1 – AAL atlas

Methods

This research has been approved by The University of North Carolina at Chapel Hill's Institutional Review Board (IRB), under IRB # 24-0833.

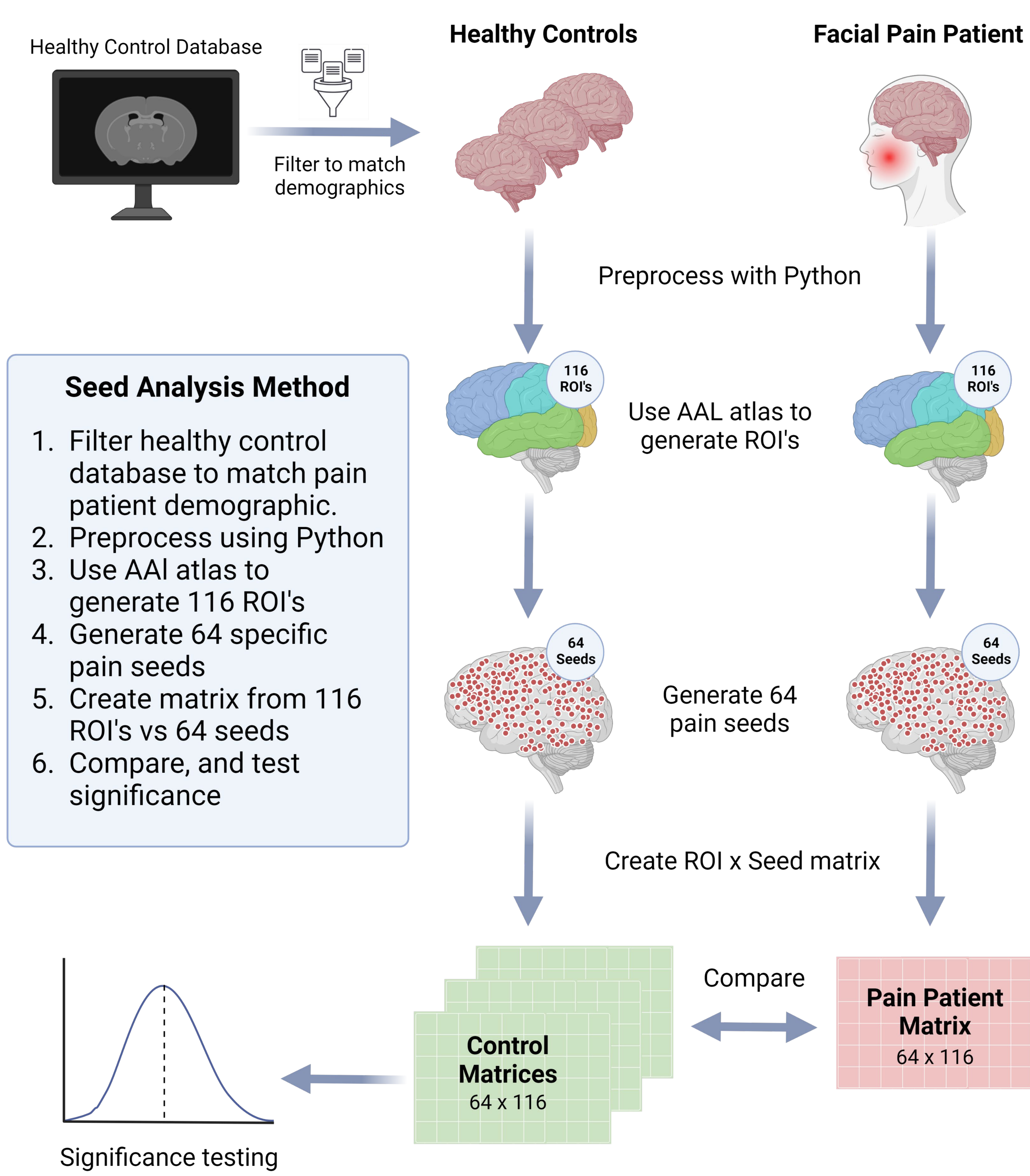

Fig. 3 – Seed analysis methods

Discussion and Results

Our findings reveal significant differences in brain connectivity networks between healthy controls and facial pain patients. Specifically, alterations were observed in regions associated with pain processing and modulation. These results underscore the complex neurobiological mechanisms underlying facial pain and highlight the importance of investigating functional connectivity patterns in understanding and potentially treating this condition. Further research is warranted to validate these findings and explore their clinical implications for the diagnosis and management of facial pain disorders.

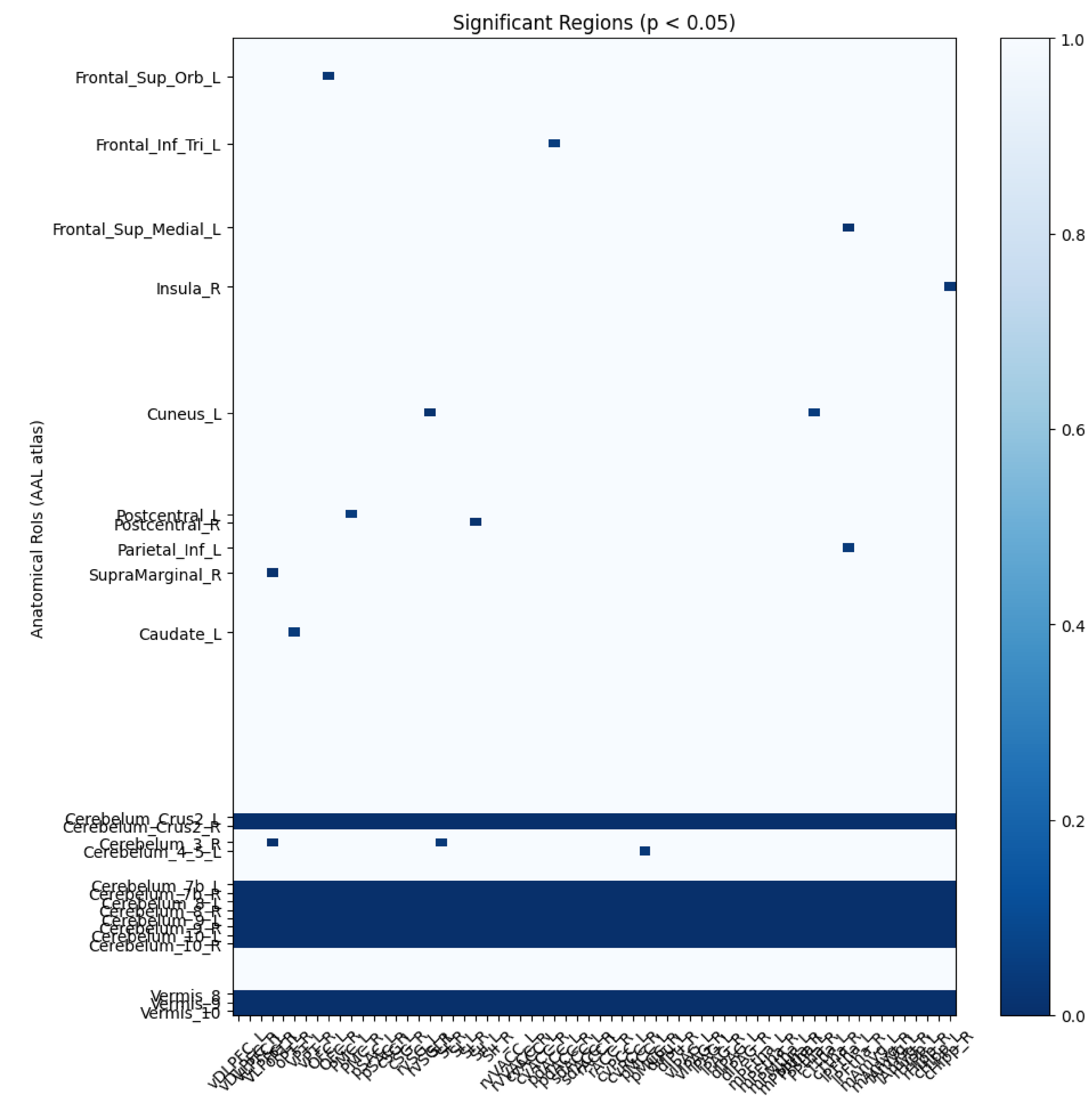

Fig. 4 – Pain patient vs. healthy control seed test significance

Comparison between Groups: It compares data from two groups (control and patient) across different regions of the brain.

Permutation Test: It checks if the observed differences in brain activity between the control and patient groups are significant or just due to chance. It does this by shuffling the data many times and seeing how often the differences are as extreme as what was observed.

Adjusting for Multiple Comparisons: Since it's comparing many brain regions, it adjusts the results to make sure it doesn't mistakenly identify differences that aren't really there.

Output: It gives a corrected p-value for each region, indicating the likelihood that the observed differences are real and not just random fluctuations.

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