Investigating Neuronal Network Dynamics Supporting Memory in the Human Brain

Thesis

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Abstract

Abstract to write here

Contents

List of Abbreviations

depth EEG depth electroencephalography

ECoG electrocorticography

EMD empirical mode decomposition

ERP event-related potential

FFA fast-frequency activity

fMRI functional magnetic resonance imaging

HHSA holo-Hilbert spectral analysis

IED interictal epileptiform discharge

ISOMAP isometric mapping

LFP local field potential

MEG magnetoencephalography

MTL medial temporal lobe

PAC phase-amplitude coupling

REM rapid eye movement

SWR sharp-wave ripple

tmEMD tailored masked EMD

UMAP uniform manifold approximation and projection

Introduction

Theta oscillations in animal models

Rodents

Memory

1 Evaluating Memory in Humans

I Associative Memory in Humans

I.1 Short-Term and Long-Term Memory

I.2 Inference Tasks in Cognitive Psychology

I.3 The Role of the Hippocampus in Inference Behaviour

I.3.a Animal Studies

I.3.b Human Lesion Studies

I.3.c Indirect Recordings of Brain Electrical Activity in Humans (fMRI, MEG)

I.3.d Direct Recordings of Brain Electrical Activity in Humans

II Investigating Inference using a Social Community Task

II.1 Behavioural Paradigm

II.2 Variants

II.2.a Simple and Complex Tasks

II.2.b Scientific Rationale for Population Diversity

II.2.c Stimulus Types and Controls

II.2.d Additional Visual Controls

2 Neural activity in the online human hippocampus is paced by a 2-Hz rhythm

I Hippocampal 2-Hz tracks mnemonic engagement

I.1 Decomposition of the human hippocampal LFP

I.1.a Prominent 2-Hz bursts structure hippocampal LFP

I.1.a.i Using tmEMD to detect slow oscillations

Description of the usual EMD. Why it fails when not optimised especially in the context of important inter-subject variaiblity. Then tailored masked EMD with optimisation of consistency and mode mixing. IMF PSDs across contacts => frequency range of the detected oscillations. Here also present wavelet spectrograms so the reader can understand how these two methods compare. How EMD captures non-linearities in the signal (phase-frequency plots) => hippocampal 2-Hz is particularly non-linear.

I.1.a.ii Hippocampal 2-Hz oscillations are transient

Detection of IMF cycles. Detection of discrete oscillatory bursts. Show multiple examples of 2-Hz bursts across contacts and subjects, particularly in contacts clear from IEDs. Quantification of bursts duration.

I.1.a.iii Local referencing reduces detection of slow oscillations

Local referencing on micro and bipolar referencing on macro => This is why we will be using CAR throughout the manuscript

I.1.a.iv Slow-oscillation amplitude and IED rate

Detection of IEDs (methods). IEDs are transient, non-oscillatory events. IEDs rate increases at rest. 1- and 2-Hz oscilltaions are more prominent in contacts clear from IEDs.

I.1.a.v Phase reversal of hippocampal 2-Hz oscillations

Echo to the introduction where we will have presented how the dipole is structured between layers, in humans and rodents. Show maybe one laminar recording from rodents. Then show phase reversal with cycle-triggered average of LFPs.

I.1.b Hippocampal 2-Hz is evoked in the memory task

I.1.b.i Hippocampal 2-Hz power increase with task engagement

Methods: one-over-f fitting. Results: Example contact; estimation plots with various controls; linear mixed-effects models. This is all using contacts free of interictal discharges (reader will unders why because we explained in the previous subsection).

I.1.b.ii Hippocampal 2-Hz bursts are evoked by mnemonic cues

ERPs changes throughout the task. Evoked 1-, 2- and 6-Hz amplitudes relate to mnemonic engagement. Correlation between evoked ERPs deflection and 2-Hz amplti-tude.

II Hippocampal 2-Hz organizes local neuronal activity

II.1

III Hippocampal 2-Hz synchronizes neuronal activity in the MTL

III.1

III.2

III.2.a

3 Discussion