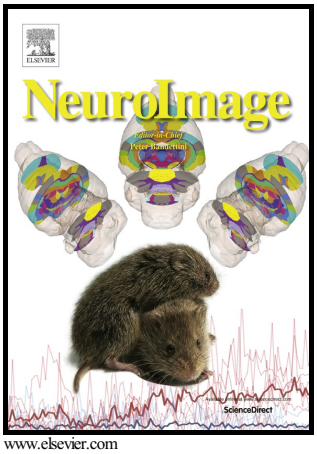
Optimization of functional MRI for detection, decoding and high-resolution imaging of the response patterns of cortical columns

Denis Chaimow, Kâmil Uğurbil, Amir Shmuel



www.elsevier.com

PII: S1053-8119(17)30300-2
DOI: http://dx.doi.org/10.1016/j.neuroimage.2017.04.011
Reference: YNIMG13952

To appear in: *NeuroImage*

Received date: 27 October 2016
Accepted date: 5 April 2017

Cite this article as: Denis Chaimow, Kâmil Uğurbil and Amir Shmuel Optimization of functional MRI for detection, decoding and high-resolutio imaging of the response patterns of cortical columns, *NeuroImage* http://dx.doi.org/10.1016/j.neuroimage.2017.04.011

Optimization of functional MRI for detection, decoding and high-resolution imaging of the response patterns of cortical columns

Denis Chaimow[1], Kâmil Uğurbil[1], Amir Shmuel[1,2]

[1]Centre for Magnetic Resonance Research University of Minnesota, Minneapolis, USA

[2]McConnel Brain Imaging Centre, Montreal Neurological Institute, Departments of Neurology, Neurosurgery, Physiology and Biomedical Engineering, McGill University, Montreal, QC, Canada

[*]**Correspondence.** Amir Shmuel. 3801 University, room NW109. Montreal, QC, Canada H3A 2B4. E-mail: amir.shmuel@mcgill.ca

Abstract

The capacity of functional MRI (fMRI) to resolve cortical columnar organizations depends on several factors, e.g. the spatial scale of the columnar pattern, the point-spread of the fMRI response, the voxel size, and the SNR considering thermal and physiological noise. How these factors combine, and what is the voxel size that optimizes fMRI of cortical columns remain unknown.

Here we combine current knowledge into a quantitative model of fMRI of realistic patterns of cortical columns of different spatial scales and degrees of irregularity. We compare different approaches for imaging patterns of cortical columns, including univariate and multivariate based detection, multi-voxel pattern analysis (MVPA) based decoding, and high-resolution imaging and reconstruction of the pattern of cortical columns. We present the dependence of their performance on the parameters of the imaged pattern and the data acquisition, and predict voxel sizes that optimize fMRI under various scenarios.

We found that all measures associated with multivariate detection and decoding could be approximately calculated from a measure we defined, “multivariate CNR” (mv-CNR), which is a function of the contrast to noise ratio and number of voxels. Furthermore, mv-CNR implied that optimal voxel width for detection and