NVC coupling.

BOLD vs EEG alpha power correlation time lag is brain state dependent

Correlate BOLD time lag with EEG alpha power decrease

Correlate alpha power with bold power differences.

More low frequency fluctuations => more alpha/beta coupling.

More alpha power => slower BOLD signal?

Hemodynamic delivery mechanisms

The brain’s blood supply regulation varies in time, during certain types of tasks or brain states, the brain may require a steady influx of blood, in other times, the influx can vary due to more limited energy demands.

Neurovascular coupling refers to the regulation of blood supply by neural activity. Neural activity requires energy, therefore when neuronal populations change their level of activity, the blood supply changes as well.

In human neuroimaging experiments, the blood supply is modeled as a convolution of neural activity with a hemodynamic response function. This function is assumed fixed with a time delay of 6 seconds from neural activity to increased venous oxygenation.

The BOLD signal itself is only an indirect measure of hemodyanic activity, reflecting oxygenation changes in the venous tissue. BOLD is not quantitative, so relative changes (%change) between time and different brain areas are often used.

Relative time, relative space – correlation.

The simple HRF, models the BOLD signal in time as a function of neural activity. Convolve a block design with an hrf and you get BOLD signal.

However, what about when we don’t know the block design, but instead want to estimate it? (Such as during resting state connectivity studies). We then need to know the hrf, to get neural activity. The HRF cannot be assumed to be the same area.

What is neural activity? Spikes, gamma, alpha/beta? Measured in humans, neural activity is EEG. In monkeys it is different.

How does EEG relate to BOLD? Different frequency bands – power – quantify time series.

Most studies have been in visual cortex of macaque.

64,64,33,9,6,50

Correlate voxels? Need to find a way to relate power differences, to coupling differences. What about across voxels? In voxels, there is a coupling difference from rest to movie, and a power difference as well. Correlate the coupling with the power difference across voxels.

Store – hrfcorrs, no difference in state/region, xcorrs – difference at specific time lags => what causes difference => coupling vs power differences

Main story for ISMRM – coupling varies as a function of state and brain area – different hrf for different frequency band and area. Same area/frequency band – different HRF, different state (quantitative differences). – time lag (s),

Coupling changes as a function of state – hrf only – increased gamma`

Results:

Average frequency-based coupling in all regions using canonical HRF

Average cross-correlation matrices in all regions

All frequencies voxel-based correlations grand average

Resting state – DMN gamma correlations, event-related = occipital gamma correlations.

T1reg to epi reg? or epireg to t1. Just invert it to a single subject’s t1.

First thing: the gamma vs rest tbrain

Get the xcorrs, average in average epi space.

Create a sub brain – each condition minus rest, each condition minus gamma, etc.

Average subtraction: rest, movie, event-related, retinotopy (t-tests) or coupling – show different surfaces.

Neurovascular coupling – modeling the vascular response using the neural response one way

Another way – uncovering the neural response based on the vascular response -> why? To better measure changes in brain connectivity. (example with connectivity).

Dynamic connectivity – changes in neurovascular coupling?

Who field of dynamic connectivity that changes in BOLD signal reflect changes in neural activity. Changes in neurovascular coupling can also cause these same effects.

Averaging across subjects – subtracting rest-everything else.

Negative => more negative values rest, positive => more positive values rest

Explaining a greater %of BOLD activity using neural activity- simply modify the time constant and combine frequency bands – independent information?

What xcorr output do you want? Mean across stimuli, mean across subjects? Mean across components? Need to invert components to native space for this…

Rest coupling doesn’t look great – because of the shitty ROI selection? Try averaging the atlas space scans, see if you get better results

2 main results:

1) different kernels in event-related, rest, and movie and different areas

How to quantify this – check coupling strength and time lag

2) at the voxel – level, plot correlation maps as a function of time lag and state

z) get the kernels grand average, find optimal delay for each freq, use that

a) get the mean correlation map for hrf, all frequencies, all

b) get the correlation map for 0-10s for xcorr.

Implications – dynamic connectivity, or dynamic coupling?