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LEICA in brief

# Goal of LEICA

The neuroimaging community has not yet found the optimal space in which to analyze dynamic functional connectivity. LEICA seeks to isolate this optimally informative space and use it to quantify dFC information content. It is expected that this optimal space will allow superior separation between conditions.

## Starting basis: information theory

### Seek to find space in which Shannon entropy of the whole brain is easily quantifiable

### Know that entropies of multiple signals add linearly if and only if signals are statistically independent

### Seek minimum sufficient dimensionality for this space

## Thus, seek space in which:

### Entropy of individual signals is easily quantifiable

### Individual signals are statistically independent

### All significantly informative dimensions are included

### No uninformative dimensions are included

# LEICA PIPELINE

## Compute phase-coherence dFC

## Extract leading eigenvector of each dFC sample matrix

## Convert leading eigenvectors into space-time matrix

## Use Marçenko-Pasteur distribution (Lopes-dos-Santos et al. 2011; Lopes-dos-Santos, Ribeiro, and Tort 2013) to detect significantly informative components

## Extract significantly informative components and their activation timeseries with ICA

## Confirm that LEICA space provides superior separation between groups:

### Using information-theoretic measures (entropy)

### Using activation time series (BOLD, dFC)

### Comparison between spaces (patient, control)

# LEICA REsults

Our dataset consists of 39 controls and 40 medicated OCD patients. From this dataset, we have computed a general space (both controls and patients), two group-specific spaces (patients, controls), and subject-specific spaces.

## Uncompressed space:

### Consists of upper (spatial) triangle of dFC array

## Average space:

### Computes distance using exponential of absolute phase difference

### Averages dFC values of each region to produce a 90-dimensional space

## General space:

### Displays 16 significant dimensions

### Allows good separation between patients and controls:

## Group-specific spaces:

### Patient space:

#### Displays more significant dimensions ()

#### Found to be less sensitive than control or general space:

### Control space:

#### Displays fewer significant dimensions ()

#### Found to be more sensitive than patient space:

## Subject-specific spaces:

### Patients display significantly more dimensions than controls

### No additional tests at present; difficult to compare spaces due to variable dimensionality.

# Model Pipeline

The previous studies have demonstrated that LEICA is highly sensitive to group-level differences in the Shannon entropy and dFC magnitudes. We intend to use this superior sensitivity to generate a dynamical model of healthy and medicated OCD brains, with the goal of extracting significant differences in working point and effective connectivity.

## Utilize standard Hopf bifurcation model

### Working point **α** = 0

### Connectivity matrix ***C*** is standard 90-region AAL template

## Cost function: Kolmogorov-Smirnov distance from simulated to empirical BOLD distribution

## Fit with particle swarm algorithm:

### Fit each subject separately

### Use ***C*** as a prior to fit effective connectivity ***EC***

### Fit **α** for each region

## Results:

### No significant differences yet found.

#### Appears that

#### It is suspected that the current fit is not sufficiently precise.

### Planned future modifications:

#### Fit **α** and **EC** separately

#### Use time-sensitive metrics to measure distances between empirical, simulated data:

##### Fourier decomposition/power spectrum

##### Matrix distance between empirical, simulation cross-spectra