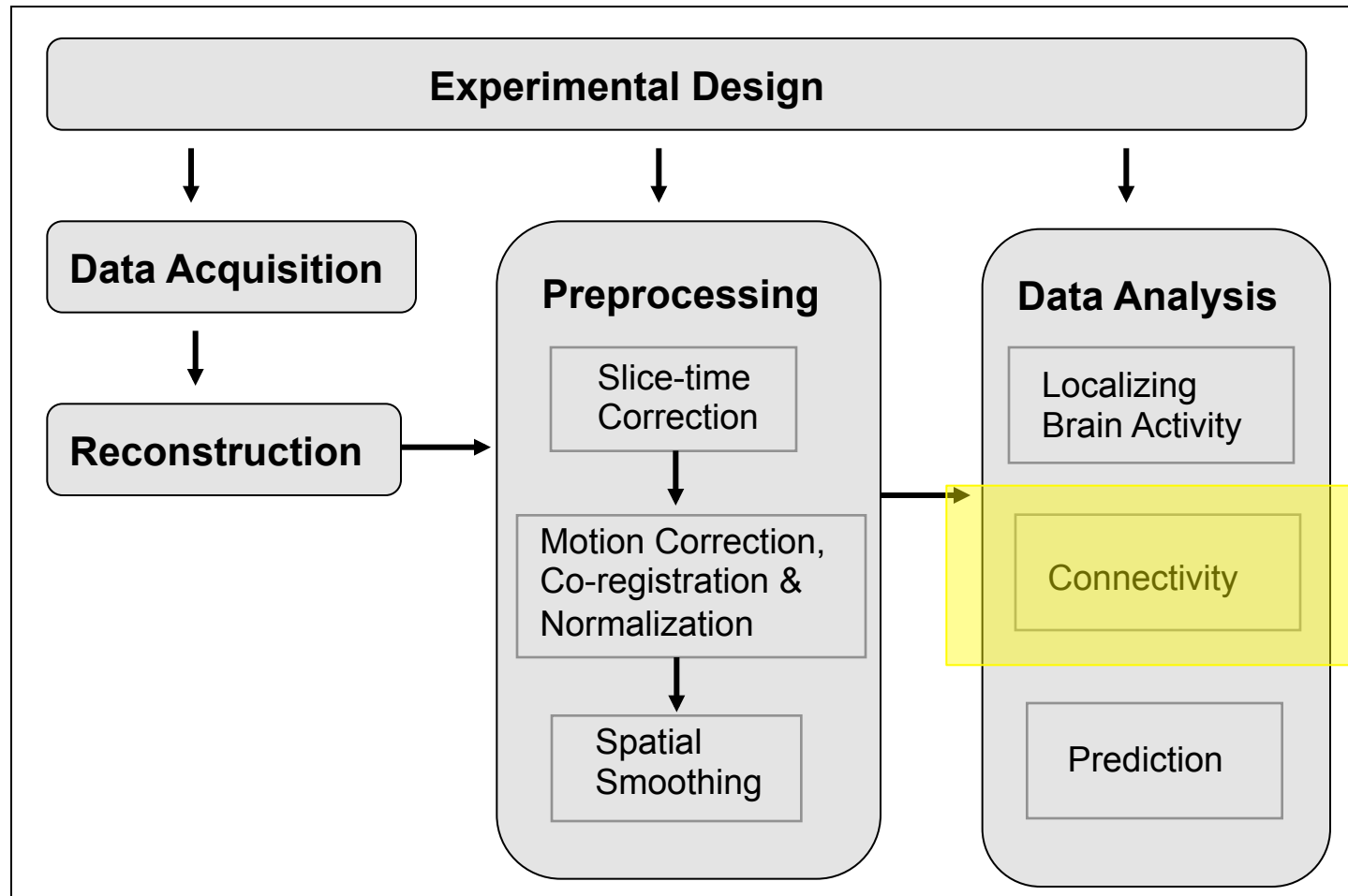


Module 22:

Brain Connectivity

Data Processing Pipeline



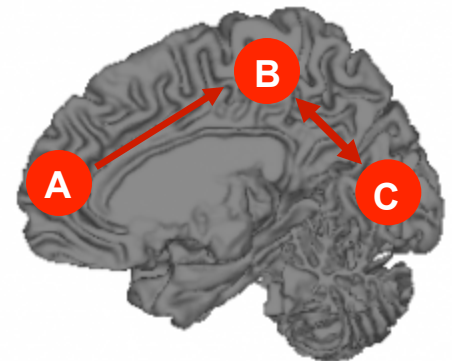
Brain Connectivity

- Human brain mapping has primarily been used to construct maps indicating regions of the brain that are activated by certain tasks.
- Recently, there has been an increased interest in augmenting this type of analysis with **connectivity studies**.
- These studies seek to describe how brain regions interact and how these interactions depend on experimental conditions and behavioral measures.

Brain Networks

- It has become common practice to talk about **brain networks**, i.e. sets of interconnected brain regions with information transfer among regions.
- To construct a network:
 - Define a set of **nodes** (e.g., ROIs)
 - Estimate the set of connections, or **edges**, between the nodes.

	A	B	C
A	0	1	0
B	0	0	1
C	0	1	0

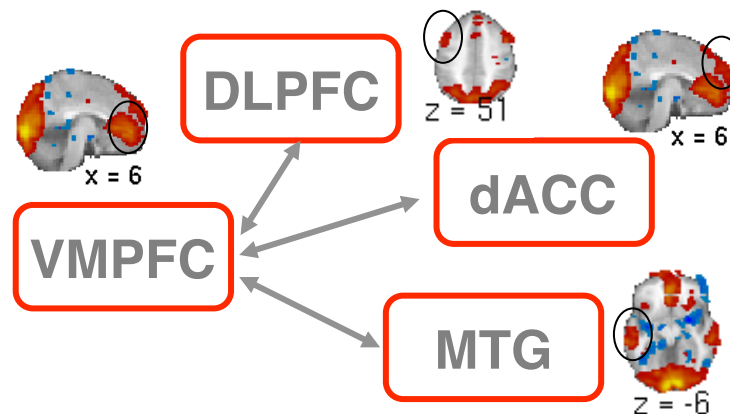


Network Methods

- A number of methods have been suggested in the neuroimaging literature to quantify the relationship between nodes/regions.
- Their appropriateness depend upon:
 - what type of conclusions one is interested in making;
 - what type of assumptions one is willing to make;
 - the level of the analysis;
 - and the modality used to obtain the data.

Brain Connectivity

- Functional Connectivity
 - Undirected association between two or more fMRI time series and/or performance and physiological variables.
 - Makes statements about the structure of relationships among brain regions.
 - Usually makes no assumptions about the underlying biology.



Functional Connectivity

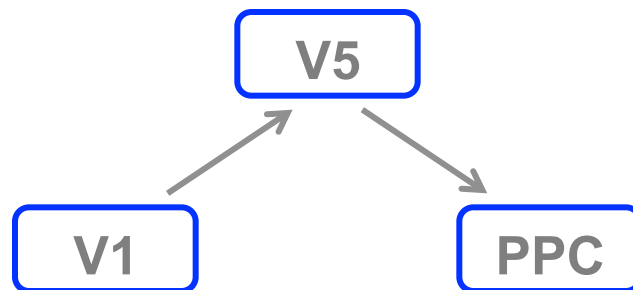
- Methods include:
 - Seed analysis
 - Inverse covariance methods
 - Multivariate decomposition methods
 - Principle Components Analysis
 - Independent Components Analysis
 - Partial Least Squares

Scope of Inference

- A goal of **functional connectivity** analysis is to make inferences on the structure of relationships among brain regions
 - “These regions form a network”
 - “Regions are more connected during task A than B...”
 - “This task is associated with activation of pain pathways...”

Brain Connectivity

- **Effective Connectivity**
 - Directed influence of one brain region on the physiological activity recorded in other brain regions.
 - Claims to make statements about causal effects among tasks and regions.
 - Usually makes anatomically motivated assumptions and restricts inference to networks comprising of a number of pre-selected regions of interest.



Effective Connectivity

- Methods:
 - Structural Equation Modeling
 - Granger Causality
 - Dynamic Causal Modeling
 - Bayes Net

Scope of Inference

- A goal of **effective connectivity** analysis is to make statements about causal effects among tasks and regions.
 - “Frontal cortex enhances connectivity between visual areas and hippocampus.”
 - “VMPFC inhibits the amygdala”

Levels of Analysis

- Connectivity can be studied at different levels of analysis, with different interpretations at each.
- Connectivity **across time** can reveal networks that are dynamically activated across time.
- Connectivity **across trials** can identify coherent networks of task related activations.

Levels of Analysis

- Connectivity **across subjects** can reveal patterns of coherent individual differences.
- Connectivity **across studies** can reveal tendencies for studies to co-activate within sets of regions.

End of Module



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