

Module 26:

Comments on Connectivity

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.
- **Effective Connectivity**
 - Directed influence of one brain region on the physiological activity recorded in other brain regions.
 - Makes statements about causal effects among tasks and regions.

Functional Connectivity

- A goal of **functional connectivity** analysis is to make inferences on the structure of relationships among brain regions.
- We want to make statements like:
 - “These regions form a network”
 - “Regions are more connected during task A than B.”

Effective Connectivity

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

Effective Connectivity

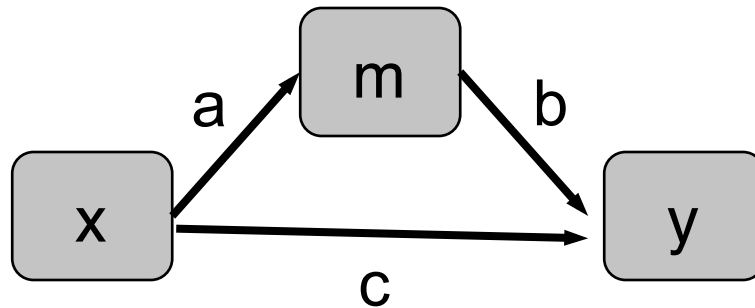
- Effective connectivity is thought to provide more powerful conclusions than functional connectivity, but makes much stronger assumptions
- The validity of the conclusions depend strongly on the assumptions being correct.
- The necessary assumptions are often poorly specified and difficult to check, which is a major shortcoming of the field.

Functional vs. Effective

- Ultimately, the distinction between functional and effective connectivity is not entirely clear.
- If the discriminating features are:
 - (a) a directional model in which causal influences are specified; and
 - (b) the willingness to make claims about direct vs. indirect connections,then many analyses, including multiple regression, might count as effective connectivity.

Illustration

- Consider the following SEM.



$$m = i_m + ax + e_m$$
$$y = i_y + bm + cx + e_y$$

- Mediation analysis

Comments

- In the end, it is not the label of “functional” or “effective” that is important, but the specific assumptions, robustness and validity of inference afforded by each method.
- More care needs to be taken in discussing these concepts in connectivity studies.
- At the end of the day connectivity should be discussed in terms of carefully defined estimands of interest not on the applied estimation algorithm.

End of Module



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