NACS 645 – Beliefs in crowds

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Valentin Guigon

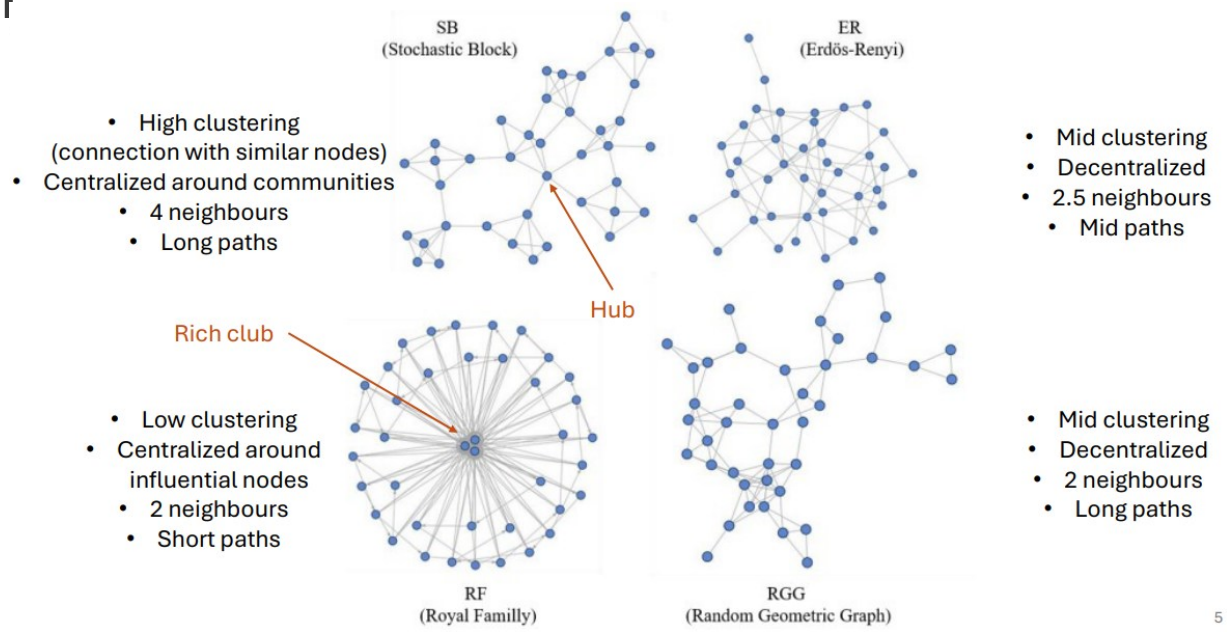
DEPARTMENT OF PSYCHOLOGY

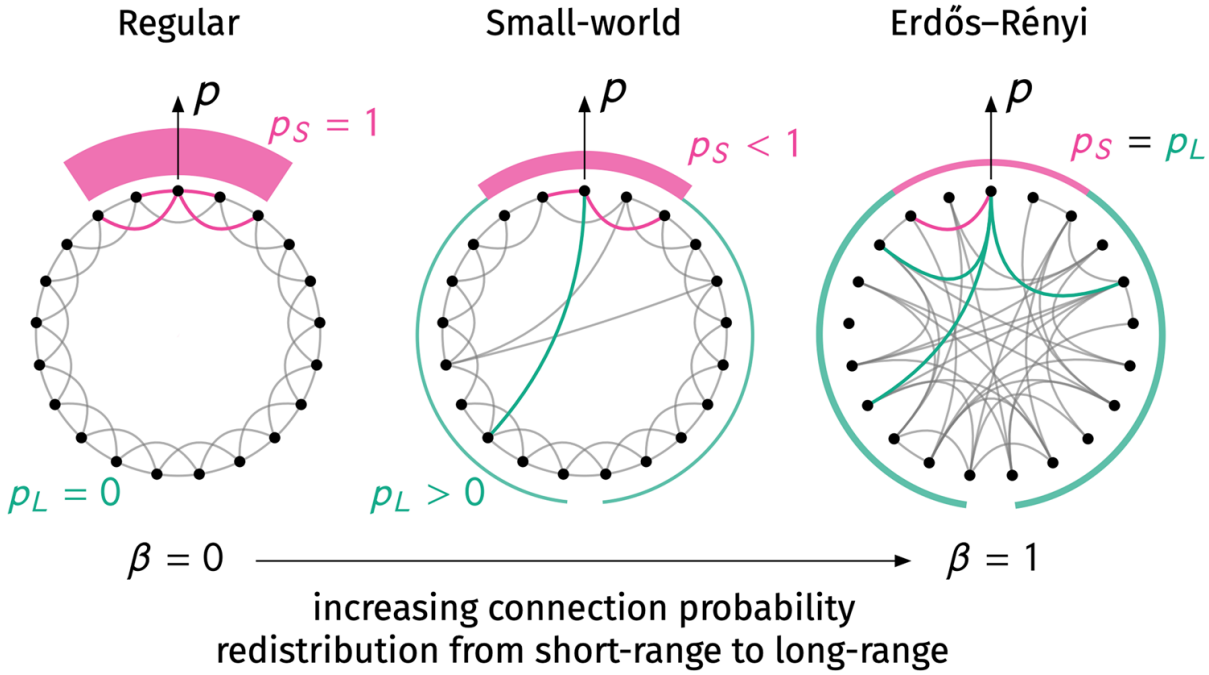
SLD Lab

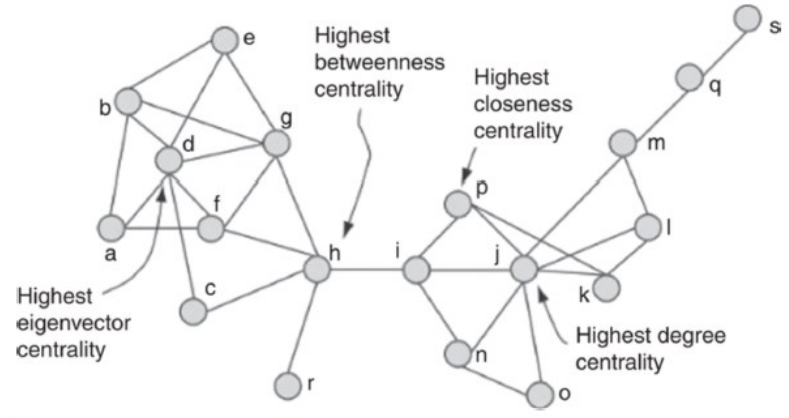
PROGRAM IN NEUROSCIENCE & COGNITIVE SCIENCE

Choi, Goyal et Moisan, 2023. *Management Science*.
Maier, 2019. *Scientific Reports*.

Network structures in the nature



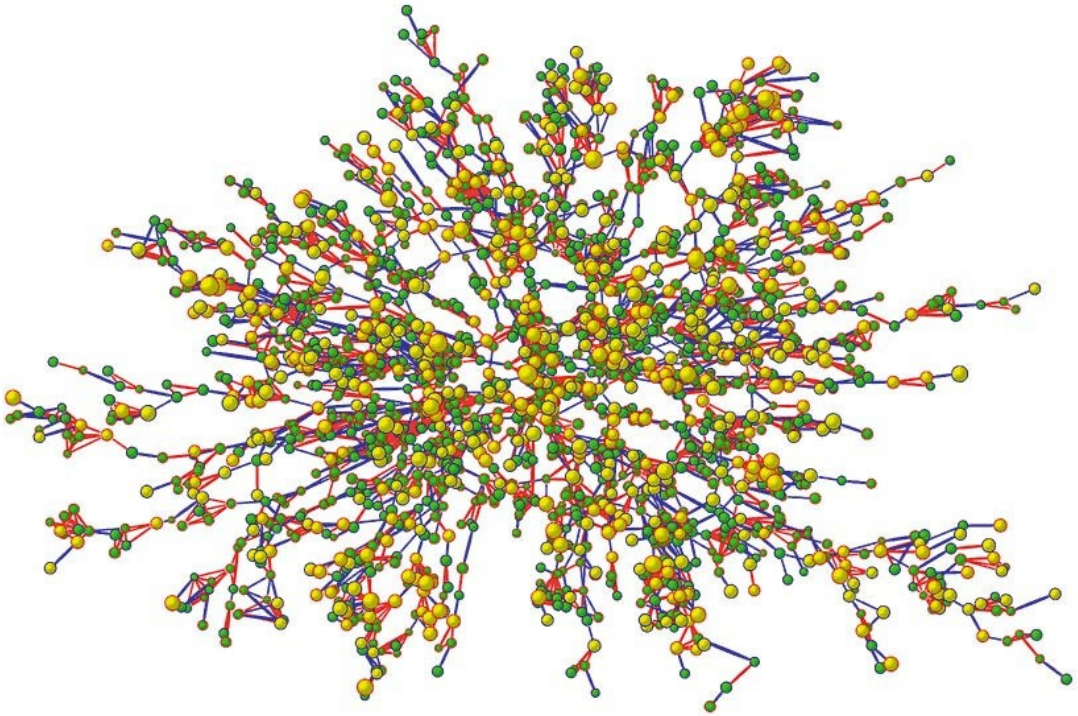




- **Degree Centrality**: number of incident edge on the node (in-degree vs out-degree)
- **Closeness Centrality**: how quickly/efficiently the node can reach the rest of the network
- **Betweenness Centrality**: how a node finds itself along the shortest path between other pairs of nodes in the graph
- **Eigenvector Centrality**: node is linked both to many nodes and to other important nodes

Christakis and Fowler, 2007. *The New England Journal of Medicine*.

Spread of obesity

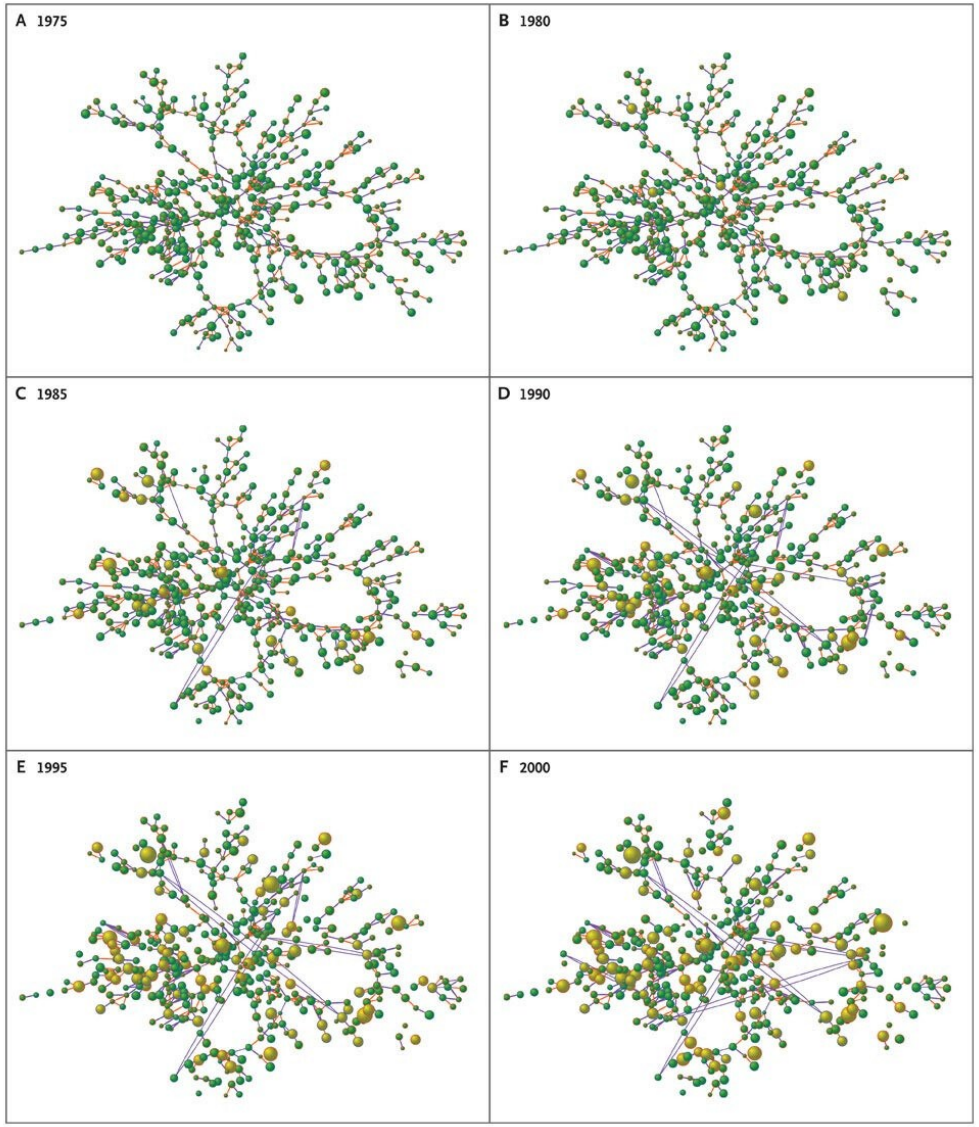


Largest Connected Subcomponent of the Social Network in the Framingham Heart Study in the Year 2000.

- A person's chances of becoming obese increased by 57% (95% confidence interval [CI], 6 to 123) if he or she had a friend who became obese in a given interval.
- Among pairs of adult siblings, if one sibling became obese, the chance that the other would become obese increased by 40% (95% CI, 21 to 60).
- If one spouse became obese, the likelihood that the other spouse would become obese increased by 37% (95% CI, 7 to 73).
- These effects were not seen among neighbors in the immediate geographic location.

Christakis and Fowler, 2007. *The New England Journal of Medicine*.

Spread of obesity



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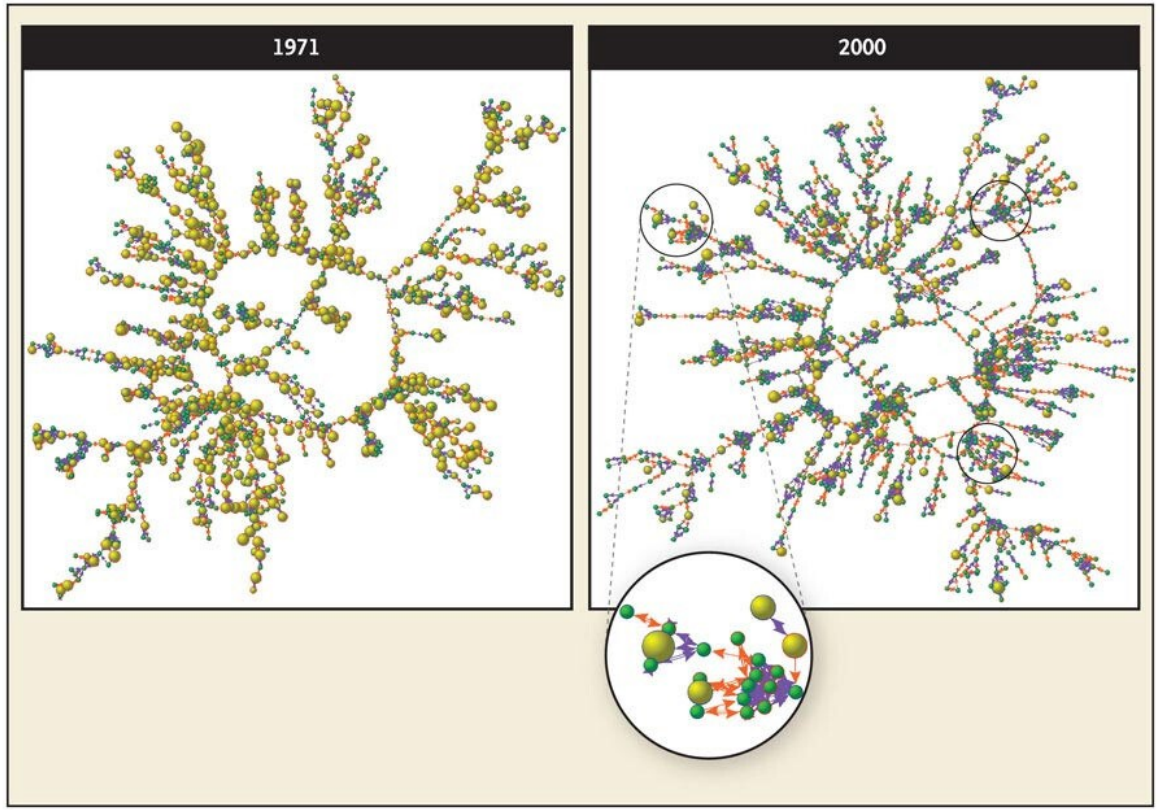
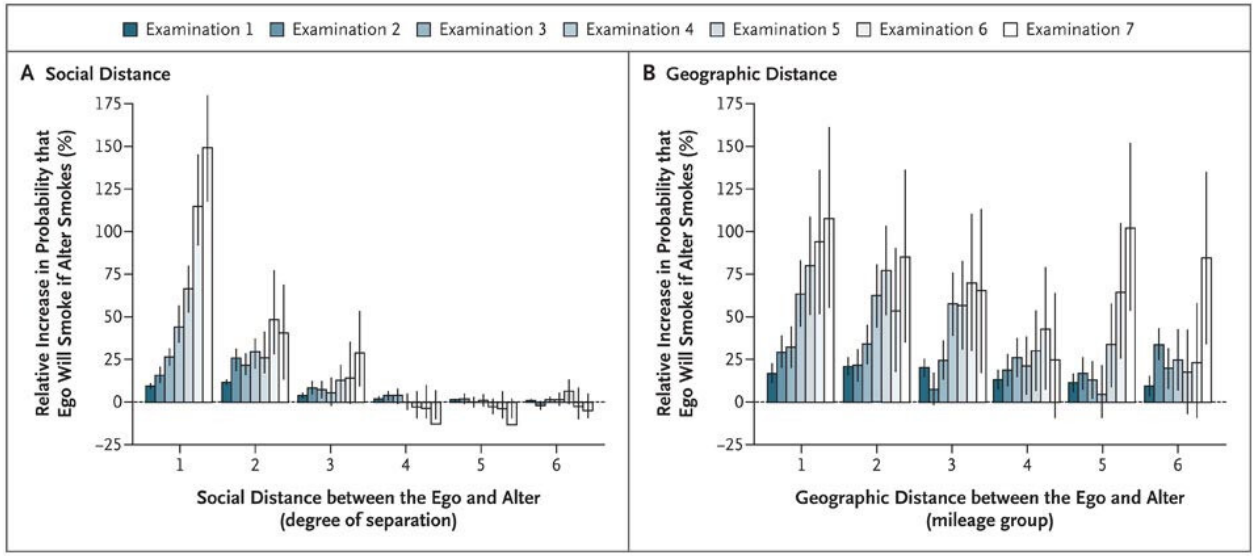
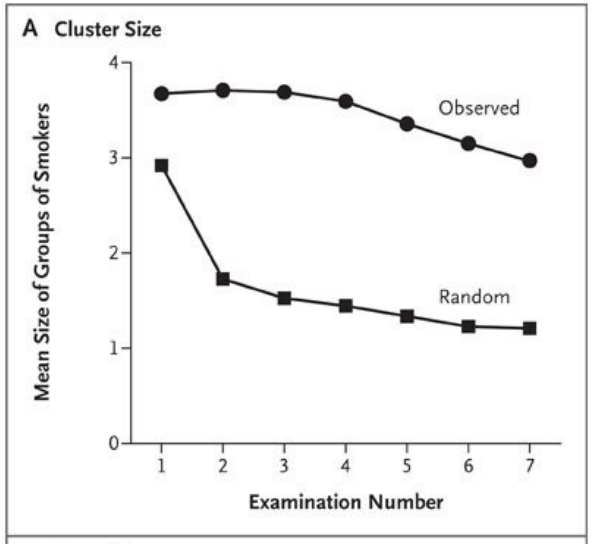
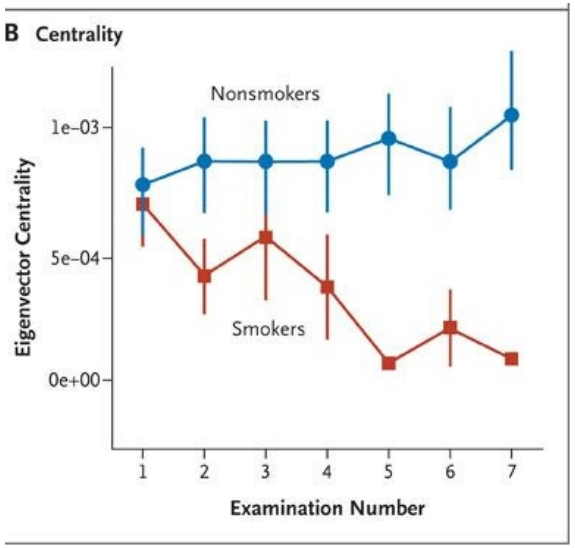
Spread of smoking and cessation





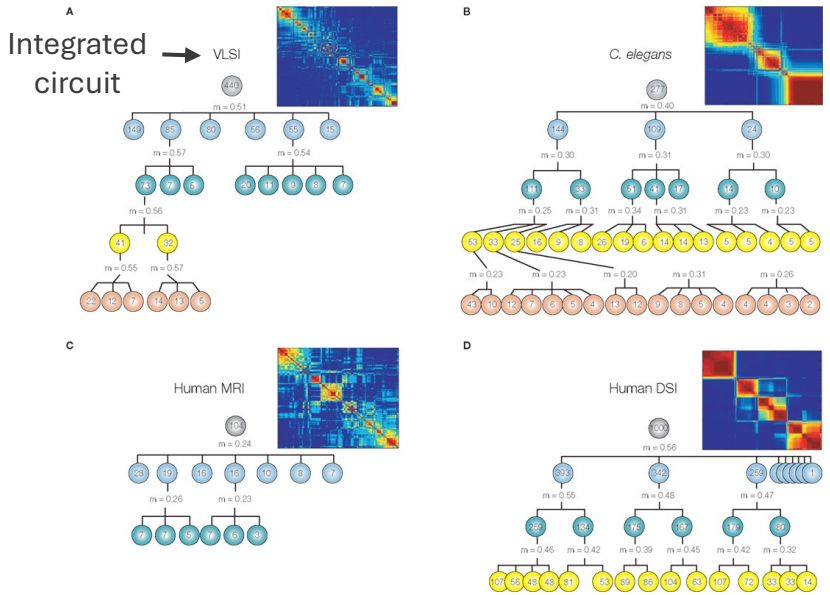




Contagions

- Contagion (e.g., diseases, beliefs) vs adoption (e.g., technologies, norms)
- Complexity:
  - simple contagions –i.e., “contagions for which a single activated source can be sufficient for transmission“
  - complex contagions –i.e., “behaviors, beliefs, or attitudes for which transmission requires contact with multiple sources of activation”
- Various thresholds for adoption
- Spread: percolation, contagion, threshold-based (clapping), cascades, and more
- Facilitators: norms, identity, metabeliefs, homophily, network interactions, multiplicity of sources

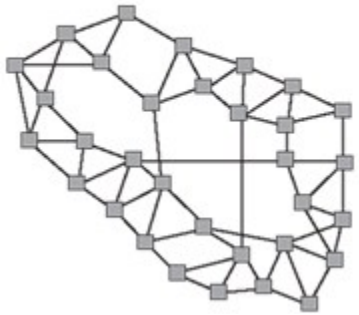
Small worlds



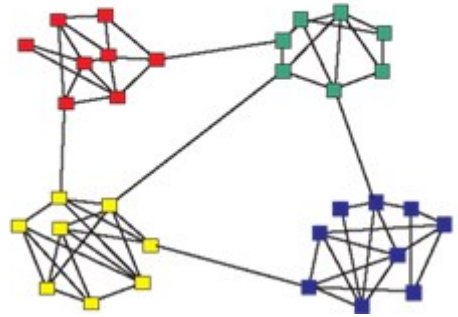
Diffusion spectrum imaging

Meunier, Lambiotte et Bullmore, 2010.
Frontiers in Neuroscience

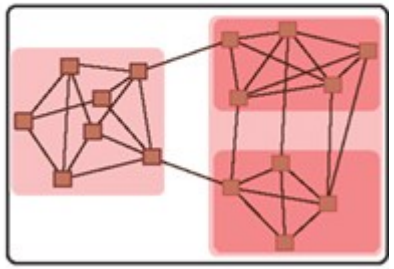
Small-world



Module



Hierarchy

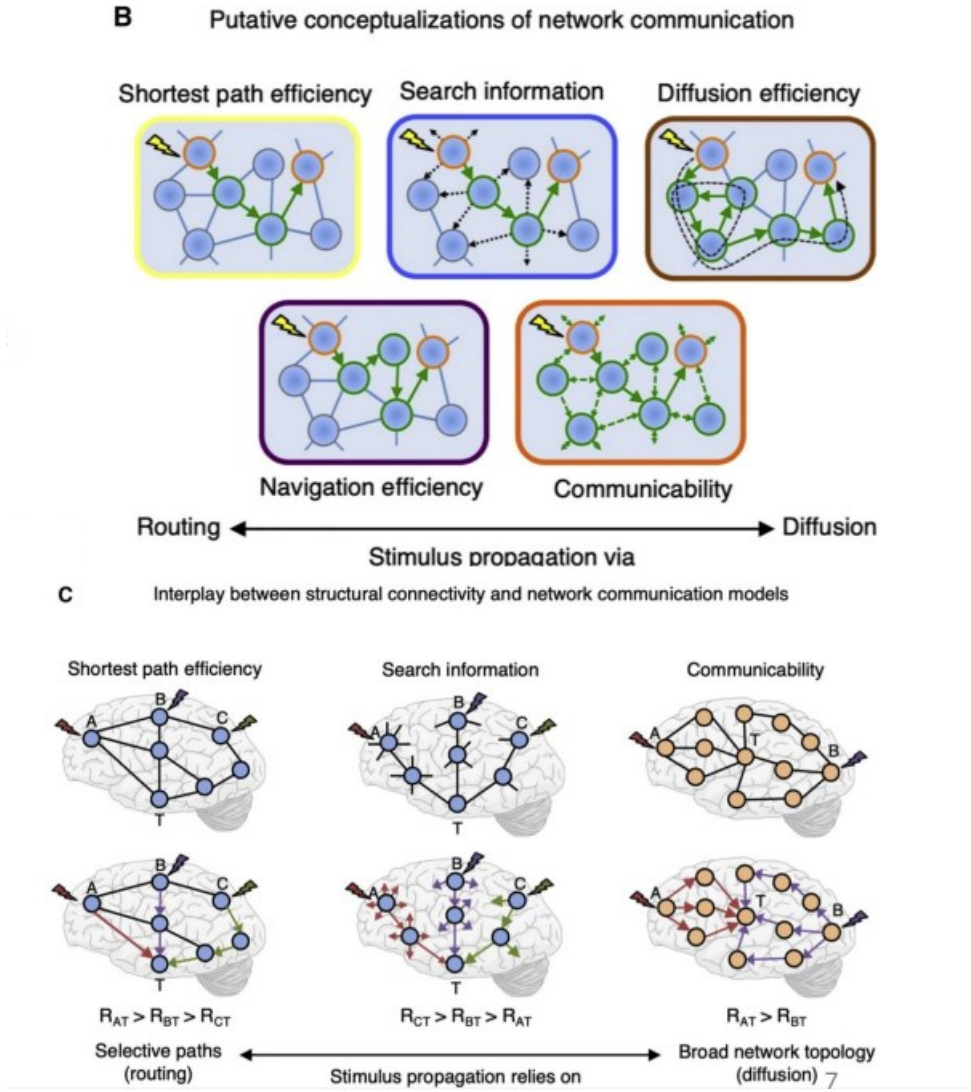


Module
(specialized function)

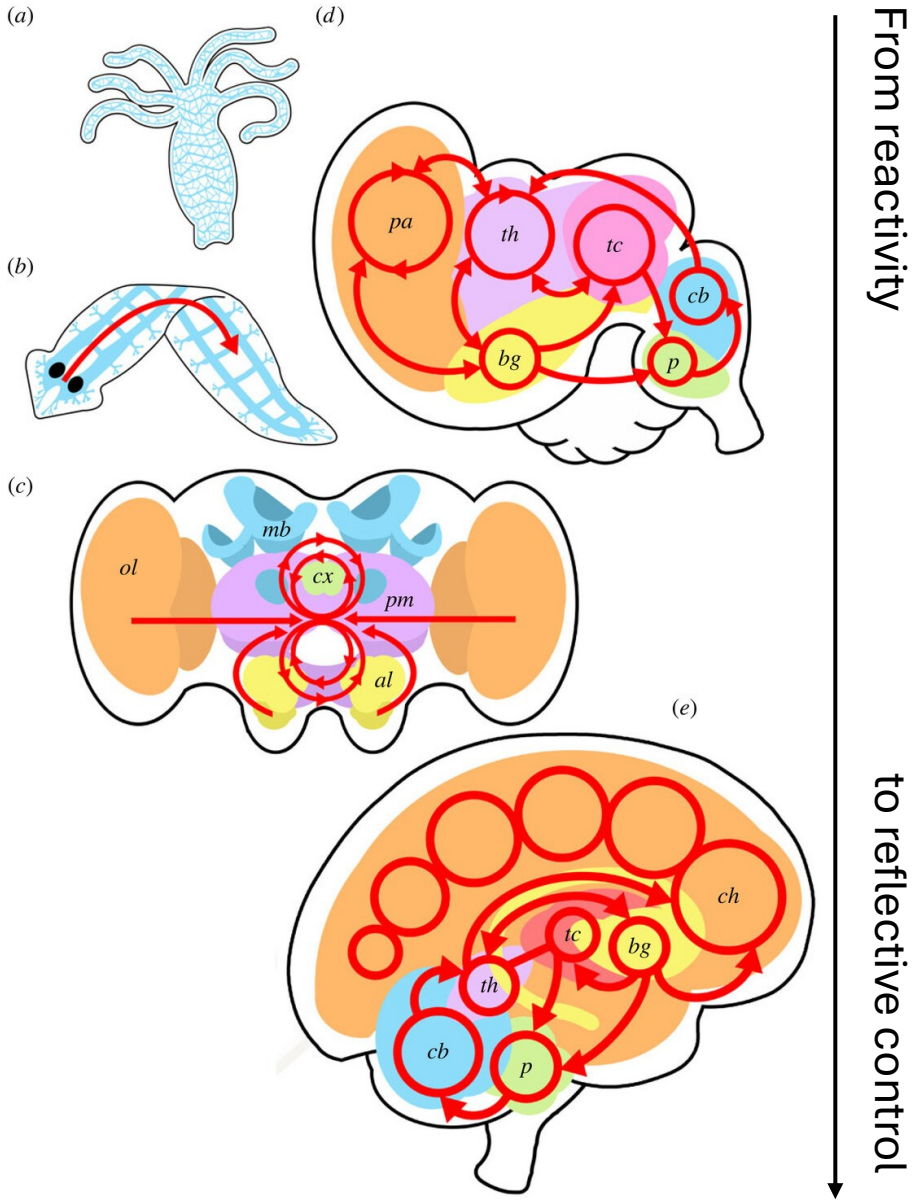
Sub-modules
(segregated processes)

- **Small-world design:** Favors high clustering within modules supports **locally (fast) segregated processing** at low wiring cost, while short path lengths **enable global integration** for generic (slower) processing. Allow for redundancy and submodularity.

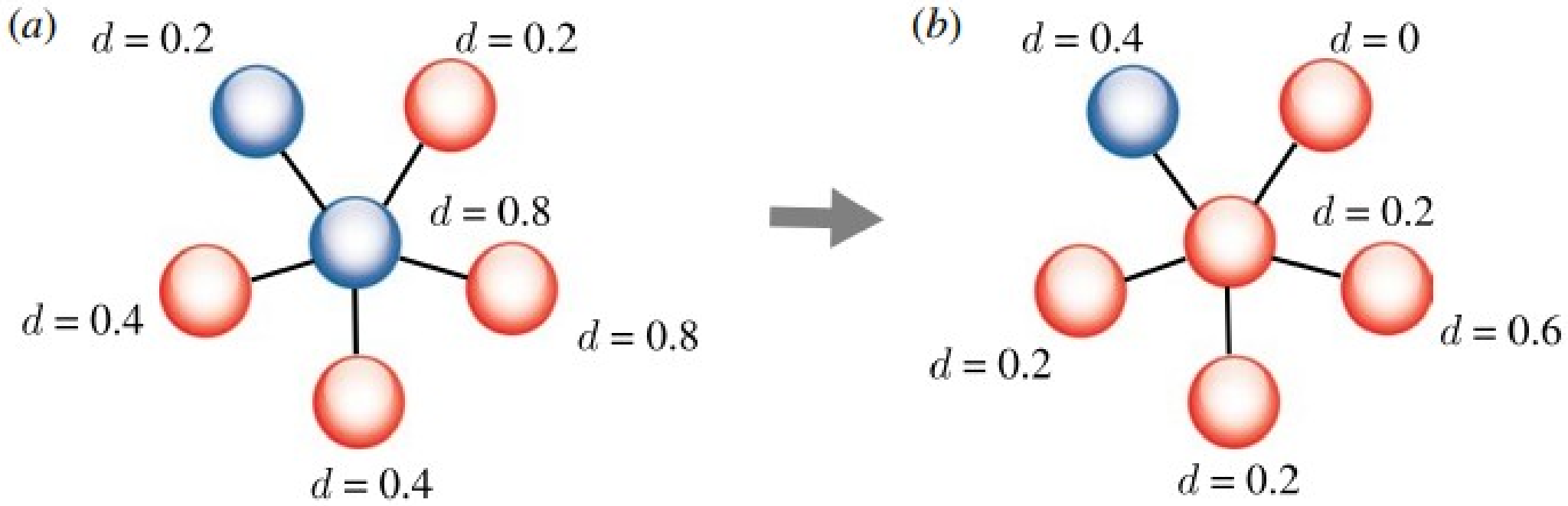
Signal propagation



Seguin et al., 2023. *Neuron*.
Barron, Halina & Klein, 2023. *Proceedings of the Royal Society B.*



Opinion formation



Visual representation of the opinion formation process.
Adapted from: Salathé and Bonhoeffer, 2008, *Journal of The Royal Society Interface*.