Implications of Robustness for the Theory of Explanation

Mark Povich
Philosophy-Neuroscience-Psychology
Washington University in St. Louis

Question: Are explanations of robustness causal-mechanical explanations?

Example: Why are macaque cortical networks robust?

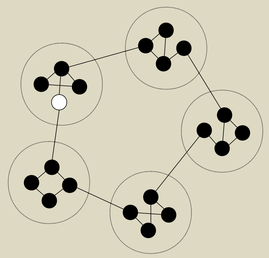
Two Views:
1. Explanations of robustness are not causal-mechanical.
No mechanism components or their activities are identified, temporal sequence of events is irrelevant [1].
2. Explanations of robustness are causal-mechanical.
They satisfy a principal norm of mechanistic explanation by allowing manipulation and control of the explanandum phenomenon [2].

My Thesis – A Middle Way: Explanations of robustness are "really statistical" [3] but can be accommodated by a generalization of the norms of causal-mechanical explanation.

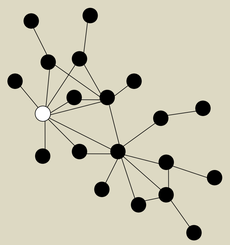
Network Definitions

Robustness: The stability of a network property to random deletions of nodes or edges [3]. Common measure: characteristic path length, i.e. average shortest path [5][6][7][8].

Modularity: Network organization characterized by clusters of nodes highly connected to each other (modules or communities), with few connections between clusters. Also called "community structure" [8].



Scale-free: Network organization characterized by a power-law degree distribution: $P(k) \sim k^{-\gamma}$ where P(k) is the fraction of nodes of degree k [10].



Explanandum: Robustness of macaque cortical networks.
Explanans: Scale-free organization [5].

Not Causal-Mechanical, but Really Statistical: Scale-free organization makes robustness "a statistical fact of life" [3]: it follows from the laws of probability that a network with scale-free organization will be robust. The explanandum is neither caused nor constituted by the explanans. Why?

Noncausal Dependence and Explanatory Asymmetry: The asymmetric but noncausal dependence involved between our explanandum and explanans is akin to that between realized and realizer or determinable and determinate [11]. This accounts of the intuitive explanatory asymmetry: robustness does not explain scale-free organization. It does not follow from the laws of probability that a robust network will have scale-free organization. Modular networks, for example, are also robust [3].

Generalizing Causal-Mechanical Norms: This account adheres to central norms of causal-mechanical explanation [12] [13] by answering w-questions and allowing manipulation and control. Contra Zednik [2], this does not make explanations of robustness causal-mechanical because manipulations of robustness involve non-ideal interventions [14]. This account is compatible with both ontic and epistemic conceptions of scientific explanation.

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Email: mapovich@gmail.com