The Basis of Organization in Interactive Processing Systems

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The idea that the human cognitive system might consist of a collection of reflexive, autonomous, encapsulated modules serving a general-purpose, open-ended 'central module' was made popular by Fodor in his book, 'The modularity of mind'. The evidence for this view consisted of putative cases of so-called autonomous processing, particularly in lexical access and syntactic parsing. The evidence for this autonomy has not held up, and there is now a wide range of theory and data exploring the ways in which multiple sources of information can be simultaneously exploited for such purposes as segmentation of visual scenes into objects, recognition of phonemes, letters, and words, and assignment of structural relations among constituents of sentences.

Yet it would be absurd to suppose that there is no organization to the cognitive system. The separation of the primary cortices into visual, somatosensory-motor, auditory, and gustatory/olfactory cortices; the further subdivision of the visual system into the dorsal and ventral streams; and the fragmentation of memory, language, and reading following circumscribed lesions to the brain all suggest that the cognitive system is certainly not 'one huge undifferentiated mass of connectoplasm'.

Two of the challenges, then, that face cognitive science and cognitive neuroscience today are the dual challenges of determining (1) how integration occurs within such a highly structured system, and (2) why a system that is so integrative has such a high degree of organization.

The talk will consider what light can be shed on these matters by considering optimal Bayesian approaches to the construction of interpretations of inputs, given the properties that govern their structure. It will turn out that for some cases, at least, optimal organization will imply a certain kind of functional organization; the resulting physical organization can then be understood as reflecting a way of realizing the functional organization with the minimum allocation of hardware (specifically wiring in the form of axonal projections that carry information from one place to another in the brain).