The Architecture of Cognition: Rethinking Fodor and Pylyshyn's Systematicity Challenge

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The Architecture of Cognition explores two questions. The first question is whether human thought is systematic; the second is how we can best explain the systematicity of human thought, if human thought is in fact systematic. To answer these questions, the volume takes as point of departure Fodor and Pylyshyn’s (1988) claims that human thought is systematic and that systematicity is not explained by a “Connectionist” cognitive architecture. Rather, systematicity is best explained by a “Classical” cognitive architecture, which postulates a system of representational states that have combinatorial syntactic and semantic structure—a language of thought.

According to Fodor and Pylyshyn (1988), the systematicity of thought is an empirical fact. If humans have the ability to have certain thoughts, then they also have the ability to have other thoughts with semantically related contents. Fodor and Pylyshyn’s contention is that an adequate explanation of systematicity requires a compositional system of representations, which is a defining feature of a Classical cognitive architecture. If a Connectionist architecture lacks a compositional system of representations, then it cannot explain systematicity, and so it cannot offer an adequate alternative to Classicism as a general theory of cognition. Connectionism can offer at best a general theory of how a Classical cognitive architecture might be implemented in neural networks.

Fodor and Pylyshyn’s (1988) argument has attracted tremendous interest over the last 25 years and has raised questions about the nature of explanation in cognitive science, about what theories of human cognitive architecture should look like, and about whether systematicity is a genuine feature of human psychology. The Architecture of Cognition not only takes stock of these ongoing debates, it also pushes the debates further, in novel directions, by examining recent approaches to explaining cognition and behavior, including approaches in computational neuroscience, dynamical systems theory, ecological psychology, and enactivism.

The 17 essays in The Architecture of Cognition are organized into 4 unlabeled sections. Section I runs from chapter 1 to 3 and serves as an introduction to the systematicity challenge. Chapter 1 by Symons and Calvo reviews Fodor and Pylyshyn’s (1988) argument, explaining the central notions of systematicity and cognitive architecture, and relating them to the associationism/rationalism dichotomy. In chapter 2, McLaughlin examines Smolensky and Legendre’s (2006) proposal that an integrated Connectionist/Symbolic architecture can successfully tackle Fodor and Pylyshyn’s challenge. Reiterating the point made in Fodor and McLaughlin (1990), McLaughlin argues that Smolensky and Legendre’s architecture can explain systematicity only by implementing a language of thought. In chapter 3, Aizawa scouts some old and new difficulties for Fodor and Pylyshyn’s systematicity challenge; in particular, he considers Post-Connectionist approaches that erase the distinction between cognition and behavior.

Section II comprises seven chapters, which take the perspective of artificial and biological neural networks and address how and to what extent human thought is systematic. The section focuses on language, presenting experimental results that argue for a rapprochement between Connectionist and Classical architectures.

Section III includes four chapters that relate systematicity to four current issues in the philosophy of psychology and in cognitive science. These issues span dual-process theories of cognition (chapter 10 by Ramsey), the extended mind hypothesis (chapter 11 by Coram), concept pluralism (chapter 12 by Martínez-Manrique), and neo-empiricism (chapter 13 by Machery).
Section IV consists of four chapters which assess the nature of the systematicity of thought from a variety of post-cognitivist perspectives. Specifically, Chemero concentrates on dynamical systems theory in chapter 14. Travieso, Gomilla, and Lobo take up a neo-Gibsonian approach in chapter 15. Calvo, Martin, and Symons consider cognition in plants in chapter 16. In the final chapter, chapter 17, Silberstein asks how a network-neuroscience perspective can advance the understanding of disruptions of systematicity in schizophrenia.

Having provided an overview, I now zoom in on four chapters, which I found especially stimulating. Aizawa’s “Tough Time to be Talking Systematicity” is divided into two parts. In the first, Aizawa draws on his (2003) book to clarify that the force of systematicity arguments partly depends on the explanatory standards one embraces in cognitive science. In the second half of the essay, Aizawa argues that Post-Connectionist approaches in cognitive sciences, like ecological psychology, enactivism, and dynamical systems theory, tend to conflate the distinction between cognition and behavior, which would undercut systematicity arguments. The idea is that if cognition just is behavior, then it is misguided to ask questions about the cognitive mechanisms underlying putatively systematic behavior.

While Aizawa is right that Post-Connectionist approaches make “for tough times to be talking systematicity,” this may not be because these approaches focus on behavior and obliterate cognition. Rather, it may be because these approaches generally resist the idea that representations play a useful explanatory role in describing a cognitive system. This anti-representationalism clashes with one central assumption of Fodor and Pylyshyn’s (1988) argument, namely, the assumption that a theory of cognitive architecture must posit representational (or intentional) states. For Fodor and Pylyshyn, it is representation that makes a phenomenon cognitive, and the systematicity of thought is a paradigmatic cognitive phenomenon. If Post-Connectionist approaches reject representations, then it is obvious that they cannot offer an explanation of systematicity or a theory of cognitive architecture in Fodor and Pylyshyn’s sense.

In “PDP and Symbol Manipulation: What’s Been Learned Since 1986?” Marcus argues that the human mind does not represent structures like the syntactic trees studied in linguistics. We instead use “cobbled-together substitutes for trees, in which linguistic structure can only be represented in approximate fashion, by means of sets of sub-trees … that are bound together in transitory and incomplete ways” (p. 107). While this example demonstrates that it is problematic to claim that human thinking or human language are genuinely systematic (Johnson, 2004), the example also shows that a more fruitful approach to understanding the mind is to pursue a pluralism of explanatory resources that include symbolic representations and statistics.

Ramsey makes a somewhat similar point in “Systematicity and Architectural Pluralism.” He argues that some form of systematicity is a genuine feature of human psychology and that connectionist architectures do not provide an adequate explanation of such a feature of human thought. However, “if we assume that the mind is made up of different systems and processing architectures with very different representational capacities, then the systematicity argument against connectionism loses its force as a refutation of connectionism” (p. 264). Ramsey clarifies that all that is needed for connectionists to respond to Fodor and Pylyshyn’s challenge is that some portion of cognition does not involve systematically related representational states.

However, it is not obvious that this response allows connectionists to face up to Fodor and Pylyshyn’s actual challenge. Fodor and Pylyshyn (1988) were after a general theory of cognition, a theory that could explain at least a large set of cognitive phenomena. If it turned out that just a small, peripheral portion of cognition is sustained by a Connectionist architecture, that would not speak in favor of Connectionism as an alternative to Classicism for explaining cognitive processes in general.

Chemero’s “Systematicity and Interaction Dominance” argues that “interaction-dominant systems cannot exhibit systematicity” (p. 354). In these systems, the effects of components’ non-linear interactions dominate the intrinsic dynamics of each component so that “one cannot isolate components to determine exactly what their contribution is to particular behavior. … Interaction-dominant systems are in a deep way unified” (p. 360). If one cannot isolate component parts in interaction-dominant systems to determine their contribution to particular behaviors, then, according to Chemero, such systems cannot exhibit compositionality, because “a system exhibits compositionality when it has parts that make the same contribution to every representation in which they appear” (p. 361). If they cannot exhibit compositionality, then they cannot exhibit systematicity since systematicity requires compositionality.
I have a couple of concerns with this argument. Although interaction-dominant systems may be unified “in a deep way,” it does not follow that they are not modular, and it does not follow that it is never fruitful to analyze the behavior of the system by focusing on particular portions of it. A productive notion of modularity grounded in network science is consistent with systems with highly non-linear dynamics (Colombo, 2013). Furthermore, “choices about where system boundaries (and sub-boundaries) are can be important for the ways we talk about them” (Eliasmith, 2012, p. 76), as well as for the ways we understand functionally the behavior of the system (Colombo, 2009). Another concern is that Chemero’s argument seems to understand “parts” as physical components of concrete systems, while in Fodor and Pylyshyn’s argument “parts” are understood differently as semantic and syntactic items whose relationships should be individuated functionally. When a Classical architecture is implemented, the semantic relations between complex expressions in the language of thought and their parts need not line up with physical or spatial relations between complex physical parts and sub-parts of the system. So, the case of an interaction-dominant system need not constitute a threat to Fodor and Pylyshyn’s argument.

All in all, The Architecture of Cognition delivers what the editors promise. It re-examines Fodor and Pylyshyn’s systematicity challenge for a Post-Connectionist era and sheds light on how cognition could be systematic, and in which ways the systematicity of thought could be explained or, rather, negated or dismissed altogether.

The volume also delivers something it did not make explicit. As a whole, The Architecture of Cognition seems to suggest that the real challenge of Fodor and Pylyshyn’s (1988) article for a Post-Connectionist era lies in understanding whether and in which sense cognitive science should hope for a general unifying theory of cognition. Although in many episodes in the history of science the pursuit of general unifying theories led to genuine progress, cognitive science may be different from other sciences in this respect. It may well be the case that cognitive science cannot be unified, and that there is no single general theory of cognition to hope for. One of the merits of The Architecture of Cognition is that it helps us see this challenge more neatly, highlighting how a multifarious landscape of possibilities is currently available for studying and explaining cognition.

References


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