



ABSTRACTS

What is systematicity?

Brian McLaughlin (Rutgers, US)

Jerry Fodor and Zenon Pylyshyn posed a number of challenges to any would-be connectionist theory of cognitive architecture. One of those challenges was to explain the systematicity of thought without implementing a classical cognitive architecture. They maintained that if connectionism fails to explain the systematicity of thought, then it is an inadequate theory of cognition. And they maintained that if connectionism explains the systematicity of thought by implementing a classical cognitive architecture, then connectionism fails to offer an alternative cognitive theory of cognition to a classical one. The responses to this dilemma are many and varied. Some have tried to show how connectionism can explain systematicity without implementing a classical architecture. And some have argued that thought is not in fact systematic. Perhaps the most frustrating response for those who side with Fodor and Pylyshyn, however, is that no real challenge has yet been proposed since it has not been made clear what the systematicity of thought even is. In my talk, I'll try to clear away some misconceptions in the literature concerning what the systematicity of thought is supposed to be and will try to explain what kind of phenomena Fodor and Pylyshyn have in mind by the systematicity of thought.

Explaining systematicity in the extended, embodied mind

Alicia Coram (U. Melbourne, Australia)

When it comes to explaining patterns in cognitive abilities such as the systematicity of mind, recent challenges to computational and connectionist modelling go beyond the provision of non-classical architectures that work within the same explanatory framework. The extended and embodied theories of mind which are often taken to underpin dynamic system's architectures provide different accounts of both the cognitive abilities that lie at the heart of the systematicity debate, and the cognitive resources that are called upon to explain these patterns. In this paper, I will argue that these theories offer a framework for understanding such patterns as effects of structural properties possessed by the contents of the extended vehicles of mental states. This shifts the explanatory burden away from the intrinsic structural properties of intra-cranial mental states that the classical explanation rests on. Furthermore, I will argue that this explanation is better able to account for the *actual* patterns that exist in cognitive abilities, which suggest minds do not exhibit the kind of systematicity that would be predicted by the classical computational theory of mind.

One to rule them all? Situated cognition, dynamical systems theory, and the systematicity challenge

Lena Kästner and **Leon de Bruin** (Ruhr-University Bochum, Germany)

This article investigates whether Fodor and Pylyshyn's systematicity challenge applies to post-connectionist views of cognition. We start by distinguishing two related but distinct research agendas within this camp. Among the post-connectionist views, dynamical systems theory is primarily concerned with the question which type of system most adequately describes a cognitive system, whereas situated approaches to cognition aim to address which features play causal or constitutive roles for cognitive processing.

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Since Fodor and Phylyshyn's challenge targets research concerned with the setup of cognitive architectures, it will, if at all, transfer to dynamical systems theory but not (directly) to situated views of cognition. In light of this, we first propose that situated views nevertheless contribute to our understanding of cognition as they show how systematic (in Fodor and Phylyshyn's sense) off-line cognition is grounded in rather unsystematic on-line system-environment interactions that are typically modeled using dynamical systems theory. We will illustrate how progressive 'decoupling' marks the transition from on-line to off-line processing using the development of false belief understanding as a case study. Secondly, we argue that systematic cognitive processes can be understood as processes within an especially constrained dynamical system. Dynamical systems theory thus meets the systematicity challenge where it applies.

The systematicity challenge to antirepresentational dynamicism?

A way out (please) of the never ending systematicity loop

Victor Verdejo (UAM, Spain)

More than twenty years of systematicity debate in the cognitive sciences seem not enough for a rewarding end. Antirepresentational dynamicism enters now into the picture with the hope of providing a new air to the old representational debate. In this paper, I argue that the hope is not justified, indeed, that the antirepresentational dynamicist proposal comes down to a renewed and much undesired systematicity challenge: either antirepresentational dynamicism does not explain systematicity or it is just an implementation of representational theories. To show this, I present a new representation-free account of systematicity (section II) according to which, pairs of nomologically connected behaviours are systematic if, and only if, they are exercises of the same behavioural capacity. I then consider, in section III, a case of insect sensorimotor systematic behaviour (i.e., honey bees communication behaviour) and argue that antirepresentational dynamicism fails to explain such behaviour unless it already presupposes a representational theory. After confirming the existence of yet another dialectical systematicity loop I recommend, in section IV, an alternative strategy: to look for different and integrated accounts of cognitive phenomena at all levels of explanation (including notably the representational level) so as to achieve a powerful and rich cognitive science.

Systematicity and multimodality: some ground-level problems for anti-representationalism

Bence Nanay (U. Antwerp/U. Cambridge, Belgium/UK)

The aim of this paper is to raise some serious worries about the recently popular view according to which there are no perceptual representations. I call this view anti-representationalism. Although anti-representationalism is more and more popular, I argue that we have strong empirical reasons for mistrusting it. More specifically, I argue that it fails to account for the most rudimentary form of systematicity: multimodal integration.

The multimodality of perception presupposes that information from two different sense modalities is unified in a shared framework. Noise coming from above and from the left and visual information from the upper left corner of my visual field are interpreted by the perceptual system as belonging to (or bound to) the same sensory individual (whatever that may be).

The auditory sense modality gives us a soundscape and vision gives us a visual scene and our perceptual system puts the two together. It is difficult to explain this without any appeal to representations. The anti-representationalist arsenal seems insufficient: appeal to active exploration is unlikely to help here and the suggestion of the world as external memory will not help either as the question is how different packages of information about the world are being united. The argument from multimodality seems to show that the phenomena anti-representationalists emphasize, be it the active and dynamic exploration of the environment or the fixation on environmental features, presuppose the coordination of information in the different sense modalities, but this can only be accounted for in representational terms. The most rudimentary form of systematicity, that is, multimodal integration, already presupposes some forms of representations.

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The explanatory value of some postconnectionist models

Jason Noble (U. Southampton, UK), **Eric Silverman** (U. Southampton, UK) and
Manuel de Pinedo (U. Granada, Spain)

Thought displays a systematicity that cannot be explained by the connections between simple neuron-like units. This is the gist of Fodor and Pylyshyn's (F & P) challenge to connectionism. Furthermore, they assume thought to be representational and there is no available method to detect representations among the mere relations between neurons and the like. In this talk we would like to question the fairness of the challenge and the correctness of the assumption, but also the need for connectionism to accept the challenge at face value.

F & P seem to force us to choose between representationalism and some form of eliminativism with respect to systematicity. However, we will argue that this is a false dilemma. An explanatory pluralism grounded on the idea that thought is a property of the relation between an agent and its environment (and peers, if any) is sufficient to decline F & P's invitation to answer the challenge by embracing connectionist explanatory fascism. This idea follows a long tradition in theoretical biology.

The possibility of such a pluralism will be explored by means of recent examples from artificial life. We will finish by wondering whether, once that we abandon representationalism, it makes sense to distinguish between explanatory and ontological pluralism.

Systematicity and Interaction-Dominant Dynamics

Tony Chemero (Franklin & Marshall Colg., US)

In its classical form (Fodor and Pylyshyn 1988; Fodor and McLaughlin 1990; Hadley 1997; Aizawa 2003), the systematicity of cognition is constitutively tied to the compositionality of the vehicles of cognition. A burgeoning research program in the cognitive sciences suggests that, in many cases, cognitive systems are interaction dominant (see Kello, Brown, Ferro-i-Cancho, Holden, Linkenakker-Hansen, Rhodes, and van Orden, G. 2010 for a review). I will describe several examples of research showing that cognitive systems are interaction dominant, and argue that interaction dominance is inconsistent with the compositionality of the vehicles of cognition. As goes compositionality, so goes classical systematicity. So, to whatever extent cognitive systems are genuinely interaction dominant, cognition is not classically systematic.

Grounding systematicity at the sensorimotor level: an ecological approach to sensory substitution

David Travieso, David Jacobs and Lorena Lobo (UAM, Spain)

The aim of our presentation is to show that the systematicity premise has taken root in the understanding of basic sensorimotor processes in the cognitivist research program. A clear-cut example is that of theories of spatial perception and the design of haptic-to-visual sensory substitution devices. Current mainstream theories of spatial perception consider that this process runs with a spatial representation of the environment that is systematically used to solve spatial behavior. Likewise, the main approach in sensory substitution is to produce an alternative input for spatial perception from that of the visual system, leaving the rest to the systematicity of the inner cognitive processes.

An alternative approach in the design of sensory substitution devices is to follow the premises of ecological psychology. That is, that the regularities in behavior are due to structured patterns that appear in the perception-action loop. Developing this framework, we present preliminary results with a simple haptic-to-visual sensory substitution prototype developed without reproducing the lower-order information of the visual system.

Concerning the possibility that the systematicity of cognition is restricted to the higher psychological processes, we will briefly present an approach to learning based on specific information in the perception-action loop called direct learning.

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Systematicity of what? Towards a systematicity of habits
Xabier Barandiaran (CNRS, France)

The work of Jean Petitot applying Catastrophe Theory to morphodynamics of cognitive grammars has shown that the classical attacks of symbolic-computationalism on early connectionisms were limited to specific types of connectionist networks but fail to prove systematicity impossible for dynamical systems generally. The current challenge that embodied and situated dynamical approaches to cognitive science face is not defending the possibility to achieve systematicity but that of finding the right units and structural scaffolding towards systematicity so as to render a genuine research program without falling back into representationalism. Following Piaget I will argue that habits and sensorimotor interactive structuring should be recovered as route from situated action to the systematicity of thought. Unfortunately, the potential of dynamical system theory has not yet provided a proper account of the systemic structure of behaviour (sensorimotor intelligence in Piaget's terminology) that is able to address even the earlier transitions from habits to more abstract schemata. Current bottom-up dynamicist models are stuck on the bottleneck of the third stage of Piaget's sensorimotor intelligence: where the plasticity of and organized system of habits is progressively equilibrated through "successive coordinations (combinativity), reversals (reversibility), detours (associativity)" that leads to the structuring of sensorimotor grouping and the construction of objects. The present challenge is to deliver a dynamical model of a system of habits capable to enact this set of transformations.

Dynamics, systematicity and extended cognition
Michael Silberstein (Elizabethtown Colg./UMD, US)

Aside from the kind of linguistic systematicity that vexed Fodor & Pylyshyn with their specific concerns about the combinatorics of semantic content and the LOT, there is a much more general and less controversial kind of systematicity that philosophers of cognitive science sometimes call inferential or transformational systematicity of thought, i.e., the logical, temporal and narrative coherence of thought as a process. It's clear that transformational systematicity really does require explanation because it's precisely what some schizophrenics and other psychotics with formal thought disorders lack. I'll first characterize formal thought disorder in enough detail to appreciate why it entails a failure of inferential or transformational systematicity of thought. Next I'll characterize a specific and novel brand of dynamics based cognitive science and its concomitant conception of extended cognition. Third I'll show that this novel dynamical conception of thought processes can help explain inferential or transformational systematicity and might help explain why it goes awry in some cases. That is, I'll be giving a new, dynamics-based understanding of such systematicity. I'll make it clear that what's doing the explanatory work with regard to systematicity is not representations with a combinatorial structure nor anything LOT like. As it turns out, such non-linearity is itself a major part of the explanation for systematicity. Finally, I'll address the central criticisms of dynamics based extended cognitive science.

Categorical compositionality: a category theory explanation for systematicity
Steve Phillips (AIST, Japan)

The systematicity challenge that Fodor and Pylyshyn posed to connectionism is essentially the same one facing theories of cognitive architecture (i.e., the basic components that generate cognitive behaviour) in the post-connectionist era. Systematicity is a property of human cognition, whereby the distribution of cognitive abilities is grouped around the common structures that those abilities refer to. The challenge is to explain why this property follows *necessarily* from the assumptions and principles of the proposed theory. Classical and connectionist theories failed to fully explain systematicity, because the assumptions/principles of syntactic and functional compositionality cannot distinguish systematic from unsystematic architectures without further, *ad hoc* assumptions. Although these forms of compositionality can implement representations of structure, neither is a theory of structure, *per se*. Category Theory is a mathematical theory of structure, *par excellence*, and provides an alternative explanation for systematicity based on the formal concept of *adjunction*, which relates a pair of structure-preserving maps, called *functors*. A functor is a structure-preserving map (of cognitive processes, for current purposes). An adjunction formally guarantees that the only pairings of functors are the systematic ones. Thus, systematicity necessarily follows from a *categorical* cognitive architecture whose basic components are functors that participate in adjunctions.

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Exploring the neural basis of systematicity with category theory
Jaime Gómez, Ricardo Sanz and Manuel G. Bedia (U. Politécnica Madrid, Spain)

In this paper we explore the concept of systematicity. We show that it is ill-defined and it needs to be explored in a rigorous way. Recently, a new account for systematicity of human thought has been proposed based on the mathematical theory of categories. This paper is an attempt to unravel why we lack a scientific -formal and falsifiable- theory of systematicity. We define systematicity and we explore a new rationale of spatial representation in the hippocampus, which as we will see, can be modeled through the categorical concept of colimit. We claim that the relationship that neurobiologists have been searching for between grid cells and place cell is a colimit. This result opens new and previously unforeseen avenues to study systematicity in cognition, in particular in memory.

Can representationalist versions of extended cognition coherently answer to the systematicity challenge?
Pierre Steiner (FNRS/U. Cat. Louvain, Belgium)

Well before the emergence of the hypothesis of extended cognition (HEC) as we know it today, some authors have tried to figure out how some neural networks could achieve *systematic conceptual performances* neither by containing structured or compositional mental representations nor by being already systematic, but by being actively *coupled with* environmental resources such as external representational structures proper to some public language (written symbols, spoken words & sound patterns, manual signs,...) (Elman 1991; Bechtel 1993, 1997; Hutchins and Hazlehurst 1995). It is thus not at all surprising today to see some proponents of HEC trying to show how HEC coupled with updated classical connectionism could answer to the systematicity challenge without appealing to syntactically structured mental representations and, more broadly, to intracranial cognitive processes alone (Menary 2007, chap.6; Clark 2007, chap.3; Rowlands 1999, chap.8). In this paper, I want to argue that as long as these proponents of HEC continue to endorse representationalism, this strategy for explaining systematicity will go *against* the inclusion of external representational structures into cognitive processes, and will thus go against a substantial part of HEC. As I will show, representationalism (the thesis according to which cognitive processes involve the production, manufacture, use or retrieval of intracranial representations having a real ontological status) is *incompatible* with the idea that the representational environmental structures with which agent are coupled may be *constituents* of their systematic cognitive processes. I will conclude with some remarks aiming to suggest how the project of accounting for the systematicity of cognitive behaviour from an extended *and non-representationalist* perspective is conceptually viable.

Systematicity and conceptual pluralism: how to pay classicism with the same (argumentative) coin
Fernando Martínez-Manrique (U. Granada, Spain)

The systematicity argument can be characterized by three claims –empirical, explanatory, and definitional– that pose a dilemma for connectionism. I begin by examining briefly the main responses given in the literature against the argument and I explain why I think they never provided a satisfactory answer. However, I also contend that the systematicity argument does not succeed in establishing classicism as the architecture of cognition, and I offer a parallel "connectionist systematicity argument" that concludes the insufficiency of classicism in that respect. First, I assume the Fodorian bottom line that cognitive life is essentially conceptual and I contrast his insistence on compositionality as a "non-negotiable" property of concepts with Evans's Generality Constraint. I argue that the latter can be interpreted as a constraint on belief attributions and not on cognitive architecture. Then, drawing on work from Elisabeth Camp, I dispute the claim that all concepts are compositional in a sense that makes systematicity a generalised attribute of mental life. Taking a pluralistic stance on concepts, I argue thus that there are conceptual elements that are not compositional in the required sense. Finally, I argue that "non-compositional" concepts exhibit a different kind of systematicity –borrowing Bermúdez's term, featural systematicity– that classicism cannot account for.

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The post-connectionist era: tough times to be talking systematicity
Ken Aizawa (Centenary Colg., US)

During the 1980's and 1990's Fodor, McLaughlin, and Pylyshyn claimed that thought is in various respects systematic. Further, they argued that so-called "Classical" syntactically and semantically combinatorial representations provide a better explanation of the systematicity of thought than do non-combinatorial representations or non-Classical combinatorial representations. During the 1990's, part of what made the systematicity arguments problematic was the subtlety of the idea of providing a better explanation. In what sense is the Classical account better than its rivals? During what we might call the Post-Connectionist era of roughly the last ten years, however, theoretical shifts have made it even more difficult to bring considerations of the systematicity of thought to bear on the nature of cognition. In this talk, I will try to articulate some of these difficulties old and new.

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