

SYSTEMS, STRUCTURAL PROPERTIES, AND LEVELS OF ORGANISATION: THE INFLUENCE OF LUDWIG VON BERTALANFFY ON THE WORK OF F.A. HAYEK.

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Abstract

This paper examines the influence exerted on the thought of F.A. Hayek by the work of the biologist and founder of systems theory, Ludwig von Bertalanffy. It is argued first of all that Bertalanffy provided Hayek with a conceptual framework in terms of which he could articulate the philosophical significance of his theoretical psychology. In particular, Bertalanffy's work afforded Hayek a set of concepts that helped him to articulate the relationship between mental and physical events—that is, between mind and body—implied by his theory. The second part of the paper builds on the first by exploring how Hayek subsequently applied the abstract conceptual framework or ontology set out by Bertalanffy to the economy. In this way, Bertalanffy's ideas helped Hayek to articulate and shape his emerging view of the economy as a complex adaptive system, which consists of different 'levels of organisation', which displays 'structural' or 'emergent properties', and which evolves over time on the basis of those group-level properties.

1. INTRODUCTION¹

This paper examines the influence exerted on the thought of F.A. Hayek by the work of the biologist and founder of systems theory, Ludwig von Bertalanffy. The background to the paper is

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provided by the fact that several distinguished commentators have observed that Bertalanffy's ideas helped to shape Hayek's thinking from the late 1940s onwards, as Hayek was developing his account of the mind, and the market, as complex adaptive systems. For example, the editor of Hayek's *Collected Works*, Bruce Caldwell, reports that Bertalanffy "read and commented on a manuscript version of *The Sensory Order*", stating that, "Hayek probably owes occasional references to the findings of 'theoretical biology' to him" (Caldwell 2004: 278 n. 14). Later, Caldwell alludes to Hayek's efforts to apply Bertalanffy's work, in particular his notion of "higher-level regularities", to the economy. Caldwell concludes that, while Hayek's emerging views on complexity were shaped by a number of people, "He was, perhaps, closest to the system theorist Ludwig von Bertalanffy" (2004: 362). A similar view has been expressed by the complexity theorist Barkley Rosser, who writes that, "[M]uch of Hayek's investigations of complexity involved cybernetics (Wiener) and its close relative, general systems theory (von Bertalanffy), with a strong influence from Warren Weaver as well" (2010: ??). The same broad theme was echoed by the Austrian economist and historian of thought Karen Vaughn, who describes Hayek in the 1950s as being "deeply immersed" in Bertalanffy's work on "the complexity of biological systems" (1999a: ??). Finally, the neuroscientist Joaquin Fuster (2011: 5) describes "the dynamic systems theory of von Bertalanffy" as an intellectual current shaping Hayek's theoretical psychology, arguing that it laid the ground for Hayek's "acceptance of a cortical dynamics in which the whole is more than the sum of the parts and [is] irreducible to them."

Insightful though these remarks are, their authors do not elaborate in detail on the nature and significance of Bertalanffy's influence on Hayek. Hence, one is left with a series of interesting, but also somewhat tantalising, claims about Bertalanffy's precise role in the development of Hayek's thought. The claims are fascinating because they point to a potentially important influence on the development of Hayek's post-war thinking about the mind and the market. But they are also tantalising because they raise, but leave unanswered, several questions: What did Hayek's references to "theoretical biology" involve and what is their import for his psychology and his economics? What is "system theory" and what lessons, if any, did Hayek draw for his economics from his study of biological "systems"? What is a "higher-level regularity" and what did Hayek's efforts to use that concept entail? What bearing, if any, does the idea that in certain systems "the whole is more than the sum of its parts" have for Hayek's thought?

The current paper seeks to build on the valuable work carried out by the scholars mentioned above by exploring, in more detail than has been done hitherto, the nature and significance of Bertalanffy's influence on Hayek. Section 2 carries out essential preliminary work by setting out the key tenets of Bertalanffy's thought. Having done so, we are then in a position to consider in section 3 how Bertalanffy's ideas helped to shape Hayek's work on the mind. As we shall see, Bertalanffy's work provided Hayek with a conceptual framework in terms of which he could articulate the philosophical significance of his theoretical psychology. In particular, Bertalanffy's work afforded Hayek a set of concepts that enabled him to articulate the

relationship between mental and physical events—that is, between mind and body—implied by his theory. Section 4 of the paper builds on that analysis by exploring how Hayek subsequently applied the abstract conceptual framework or ontology set out by Bertalanffy to the economy, in order to articulate and shape his emerging view of the economy as a complex adaptive system, which consists of different ‘levels of organisation’, and which displays ‘structural’ or ‘emergent properties’, on the basis of which it evolves over time. The final section summarises and draws conclusions.

2. VON BERTALANFFY, ORGANISMIC BIOLOGY, AND SYSTEM THEORY

Ludwig von Bertalanffy was a theoretical and applied biologist and the founder of systems theory. Born in 1901, Bertalanffy grew up in Vienna, where he attended the University of Vienna and was a student of Moritz Schlick. He studied botany and philosophy, and also worked at an experimental institute of biology. Through Schlick, Bertalanffy was introduced to the work of the Vienna Circle, whose meetings he attended and whose goal of a unified science he came to support. However, as we shall see, Bertalanffy was far less enamoured with the reductionism to which the members of the Vienna Circle subscribed, arguing that the mechanistic and atomistic approaches associated with reductionism were incapable of explaining complex biological phenomena. Bertalanffy was awarded his PhD in 1926 and published his first book, *Kritische Theorie der Formbildung (Modern Theories of Development: An Introduction to Theoretical Biology)*, in 1928 (Bertalanffy 1933). Over the course of his career, Bertalanffy worked as a theoretical and applied biologist at a variety of academic institutions in Europe and north America, achieving widespread recognition for his research on the comparative physiology of metabolism and growth, and for developing a practical method for diagnosing cancerous cells, as well as for his ideas about the nature of biological systems. He was nominated for the Nobel Prize in physiology in 1972 but died before a decision about the award could be made.²

When Bertalanffy began writing in the mid-1920s, biology was in the thrall of the so-called mechanism-vitalism controversy, and it is will be useful both for understanding Bertalanffy’s work, and also its significance for Hayek, briefly to outline the central issues of that debate. Inspired by classical physics and by philosophers such as Descartes, advocates of the mechanistic approach argued that the best way of understanding biological phenomena was to break them down into their smallest constituent parts and to analyse them in terms of the properties of those isolated individual components. Mechanism presupposes, therefore, that the world is atomistic, consisting of nothing more than the sum of its individual material parts. To use a phrase commonly employed in the interwar years, the mechanistic approach portrays the world as a *mosaic* of separate, independent atoms (Hayek 1952: 76; Haraway 2004: 6; Allen 2005: 265, 270, 275). On this view, biology would ultimately become a branch of physics, with

² For more on Bertalanffy’s life, see Davidson (1983: 45-69), Hammond (2003: 108-11), and Povureau (2009).

explanations of biological phenomena being couched in terms of the behaviour of isolated elementary physical particles.

The problem with this approach, Bertalanffy argued, was that it ignored the way in which the behaviour of the individual parts is affected by the relations into which they enter. As a result, it failed to do justice to the profound importance of those relations for the properties and behaviour of biological entities (Bertalanffy 1950a: 148, 1952: 12-13, 1933: 31-43). For Bertalanffy, therefore, it is only when physio-chemical materials are organised so as to form a particular structure that the key properties of living organisms obtain: “[I]t is the particular manner of composition of the materials and processes, their spatial and temporal organization, which constitutes what we call life” (Bertalanffy 1933: 51, 35). On this view, as Bertalanffy (1933: 35) put it in a phrase to which we shall return below, “life *is* more than a heap of physical and chemical processes and has its ‘own laws’.” The problem with reductionist approaches is that, by attempting to explain biological phenomena solely in terms of the behaviour of their isolated parts, they neglect what Bertalanffy thought was the hallmark of living things, namely the way in which the behaviour of the parts, and therefore of the biological organism as a whole, is affected by how the parts relate to and interact with each other (1933: 51).

The advocates of vitalism argued contrary to the mechanists that, far from being explicable in terms of isolated atomic causal processes, biological phenomena can be understood only by postulating the existence of a supernatural force, existing independently of the material world, that gives life to the biological world. However, according to Bertalanffy, while vitalism “recognises the character of organic order and wholeness” of the biological world, thereby avoiding the major failing of mechanism, the fact that it attributes the existence of biological phenomena to a metaphysical life-giving force implies that it portrays biological organisms as being “governed, as it were, by a host of goblins, who invent and design the organism [and] control its processes” (1952: 7-8). In doing so, Bertalanffy argues, “Vitalism means nothing less than a renunciation of a scientific explanation of biological data” (Bertalanffy 1933: 46, 45).

Bertalanffy sought to transcend the terms of this debate, and thereby to overcome its limitations, by developing what he called an “organismic” conception of the biological world that would make it possible (a) to do justice to the importance of the structural relations obtaining between the parts of an organism for its properties and behaviour, thereby avoiding the shortcomings of the mechanistic approach, while also (b) facilitating the scientific but non-reductionist analysis of biological phenomena, thereby avoiding the metaphysical excesses of vitalism (Bertalanffy 1933: 46; also see 1952: 9-54). At the heart of this new approach were four closely related concepts: the notion of a ‘system’; the notion of ‘organisation’; the concept of ‘structural’ or ‘emergent’ properties; and the idea that the world is ‘hierarchical’, in the sense that is composed of entities existing at different ‘levels of organisation’. Taken together, these concepts form an intellectual framework that underwrites a non-reductionist approach to biology that seeks to find biological laws that are quite distinct from, and irreducible to, the laws of physics and chemistry. Given that, as we shall also see, these concepts all proved to be important in the development of Hayek’s thought, it is worth elaborating briefly on each of them.

A *system* is a set of parts or elements that are related to one another in a particular way. It is, in Bertalanffy's words, "a complex of elements in mutual interaction" (1952: 11; also see Bertalanffy 1950a: 143). The set of relations that characterises a particular kind of system is its *structure*. Systems, then, are entities that arise through the organised relationship of their parts. Bertalanffy uses the notion of 'organisation' to denote the way in which individual parts must stand in certain relations to one another, forming a particular structure, if a certain kind of system—such as a living system—is to obtain. As Bertalanffy puts it, "organisms are organized things", so that "[t]he problem of life is that of *organization* ... the characteristics of life are characteristics of a system arising from, and associated with, the organization of materials and processes" (1933: 46, 1952: 12; also see Bertalanffy 1933: 49).

When individual elements are arranged into structures, their behaviour is different compared to what it is when they are isolated from one another. This is significant because it implies that, taken as a whole, systems can display properties that are quite different from the properties of their individual component parts taken in isolation. In such cases, Bertalanffy writes, "the actual whole shows properties that are absent from its parts" (1952: 12; also see p. 147). "The properties of a living cell," for example, "are very different from properties of the component proteins" (1952: 147; also see p. 12). Following the terminology of the famous zoologist and psychologist Conwy Lloyd Morgan (1926-27), Bertalanffy refers to these novel, system-level properties as *emergent properties* (1952: 197; also see Bertalanffy: 1933: v, 52).³

The notion of emergence suggests, moreover, that reality is stratified in the sense that there is a hierarchical structure of ontologically distinct systems—"a hierarchy of levels" or "hierarchical order", as Bertalanffy (1952: 26, 37, 1933: 49) variously describes it—each of which has its own distinctive and irreducible properties (Bertalanffy 1952: 23, 197). On this view, therefore, nature consists of a nested hierarchy of organised systems, with smaller systems existing within the context of larger ones in a hierarchy of levels of organisation, varying from the atomic to the molecular to the cellular to the organismic to the group, each with its own distinctive and irreducible properties. And what this implies, for Bertalanffy, is that there are distinct ('higher-level') biological laws describing the behaviour of emergent biological systems that cannot be reduced to, or replaced without loss of understanding by, the ('lower-level') laws of physics and chemistry (Bertalanffy 1933: 8-10, 28-66, 1950a: 139-40, 1952: 148-57, 181, 197).

It is worth noting explicitly that, as it is used by Bertalanffy, the term 'organisation' is not synonymous with 'designed' or 'consciously planned'. On contrary, Bertalanffy contends that the relational organisation of the elements that characterises organised wholes is an example of a "spontaneous order", whereby the biological "process as a whole carries order within itself,

³ Emergent properties can be contrasted with what are variously called *resultant*, *aggregate* or *summative* properties. These are the properties of wholes that *are* possessed by the individual elements of which those wholes are composed. Resultant properties are possessed by the individual elements irrespective of how they are related to one another, obtaining both when those elements are taken in isolation and also when the elements take the form of an unstructured aggregate or 'heap'. The paradigm of a resultant property is mass. The mass of a water molecule, for example, is simply the mass of its constituent atoms (Bertalanffy: 1933: 32-34, 1950a: 147, 1952: 10, 14).

representing a self-regulating steady state” (1952: 145, 34).⁴ In this respect, as in others, Bertalanffy argues that organismic biology constitutes an advance over vitalism in particular, which “being at one with the machine theory [i.e. the mechanistic approach] in analysing the vital processes into occurrences running along their separate lines, believed these to be coordinated by an immaterial, transcendent entelechy” (1933: 177-78; also see 1950a: 153-54). This spontaneous order arises, Bertalanffy continues, through competition: “Every whole is based upon the competition of its elements, and presupposes the ‘struggle between its parts’ ... The latter is a general principle of organisation in simple physio-chemical systems as well as in organisms and social units” (Bertalanffy 1950a: 153-54; also see p. 162).⁵

As Bertalanffy notes, in an aspect of his work that will also be relevant for understanding his influence on Hayek, the emergence of order in the biological world constitutes something of a puzzle from the point of view of second law of thermodynamics. The latter states that the amount of entropy or disorder in the universe is increasing and implies that physical interactions should proceed towards the least-ordered state possible (that is, the state of maximum entropy). It follows that order is the least probable state of affairs and chaos the most likely. Set against this expectation of increasing disorder, the fact that biological evolution has clearly displayed a tendency to produce increasingly complex and more highly organised forms of life appears anomalous. One of Bertalanffy’s signal contributions to theoretical biology was to deal with this apparent anomaly. He did do by pointing out that the second law of thermodynamics applies only to systems that are *closed* in the sense of being isolated from their surroundings. Biological systems, in contrast, are an example of what Bertalanffy termed an *open* system; they interact with the environment around them and can therefore maintain themselves in a continual, non-equilibrium steady state by importing matter and energy from the world around them and exporting their entropy or waste to it. Hence, according to Bertalanffy, open systems “need not approach maximum entropy and disorder and a standstill of processes in thermodynamic equilibrium. Instead, spontaneous order, and even an increase in order, can appear in such systems” (Bertalanffy 1952: 145; also see Bertalanffy 1950a: 154-57, 1950b: 25-27 and 1952: 112-113, 123-46).⁶

In the late 1930s and 1940s, Bertalanffy extended this emphasis on the importance of the relational organisation of phenomena into ‘wholes’ exhibiting emergent properties from the biological to the physical, psychological and social realms. His goal was to develop a trans-disciplinary framework—couched in terms of concepts such as ‘system’, ‘organisation’, ‘level’, and ‘emergence’—that was applicable to all phenomena of organised complexity, independent of

⁴ It is interesting to note that Hayek first used the term ‘spontaneous order’ in his 1955 Cairo Lectures on ‘The Political Ideal of the Rule of Law’ (see Hayek [1955] 2014: 161; also see Caldwell 2014: 14).

⁵ Hayek was quite aware of the fact that, as used by Bertalanffy, the term ‘organization’ was being used in a very sense different to that intended by Hayek in his criticisms of constructive rationalism: “The biologist will generally speak without hesitation of ‘organization’ without implying design ... [B]iology has from its beginnings been concerned with that special kind of spontaneous order which we call an organism” (Hayek 1973: 27, 37).

⁶ Hence Bertalanffy’s definition of an ‘organism’: “A living organism is a hierarchical order of open systems which maintains itself in the exchange of [its] components by virtue of its system conditions” (1952: 129).

their substance or spatio-temporal sphere of existence. Bertalanffy summarised the worldview or ontology underpinning his approach, along with the associated epistemology, as follows:

Reality, in the modern conception, appears as a tremendous hierarchical order of organised entities, leading, in a superposition of many levels, from physical and chemical to biological and sociological systems. Unity of science is granted, not by a utopian reduction of all sciences to physics and chemistry, but by the structural uniformities of the different levels of reality ... When emphasising general structural isomorphies of different levels, [systems theory] asserts, at the same time, their autonomy and possession of specific laws. (Bertalanffy 1950a: 164-65; also see pp. 139-43)

Bertalanffy termed his framework, general system theory. And, as indicated above, system theory adopts a holistic approach that—in contrast to reductionist approaches inspired by classical mechanics—emphasises (i) the explanatory significance of the relations that obtain between the elements or parts of physical, biological, and social systems for our understanding of the latter’s properties and behaviour, (ii) the way in which, based upon their emergent properties, systems interact with their environment, leading to continual evolution, and (iii) the epistemological independence (‘autonomy’) of the different disciplines (Hammond 2003: 103-41).⁷

3. BERTALANFFY’S INFLUENCE, PART I: HAYEK’S THEORETICAL PSYCHOLOGY

3.1. Hayek’s Theoretical Psychology: *The Sensory Order*

As a preliminary to considering Bertalanffy’s influence on Hayek’s theoretical psychology, we consider first of all how the account of the working of the mind set out in his principal work on that topic, namely his 1952 book *The Sensory Order* (Hayek 1952). The task Hayek sets himself in that book is to explain why the phenomenal (subjective, mental) picture of the world provided by our senses differs from the physical order revealed to us by the natural sciences. The starting point for Hayek’s analysis is the fact that there is no simple, one-to-one correspondence between the order of our sense experiences, in which events are classified according to their sensory

⁷ Bertalanffy introduced the term ‘general system theory’ at a seminar held at the University of Chicago in 1937. Other important figures in the founding of systems theory, many—though not all—of whom were associated with the University of Chicago, were the economist Kenneth Boulding, the mathematician and game theorist Anatol Rapoport, the neurophysiologist and behavioural scientist Ralph Gerard, and the psychologist James Grier Miller (Boulding 1983: 18-19; Davidson 1983: 179-81; Pouvreau 2009: 53-54). It is worth noting at this juncture that in May 1954, in a letter that also bore the name of Kenneth Boulding, Bertalanffy wrote to Hayek to invite him to join in forming “an International Society for the development, encouragement, and promotion of General System Theory.” April 1955 saw Bertalanffy invite Hayek to attend in December 1955 the inaugural meeting of what by then was called ‘The Society for the Advancement of General Systems Theory’, held in Atlanta, Georgia (Hayek Archives, Box 12-4 Bertalanffy). No response from Hayek to these letters has been found. For more on the development of the Society, see Hammond (2003: 245-67, especially pp. 245-50, and Pouvreau 2009: 127-30, 137-39, 144-47, 158-60).

qualities (colour, sound, etc.), and the physical or scientific order, in which events are classified according to their relations with other events. Objects that resemble each other in sensory terms may display very different physical relations to each other, while objects that appear altogether different to us may display very similar physical properties. There are, in Hayek's terminology, two different orders: a physical order, which is revealed to us by the natural sciences; and a phenomenal, or mental, or sensory, order which we experience as individuals. The task of theoretical psychology, as Hayek understands it, is to show how the neurons of which the human central nervous system is composed form a classificatory structure that is capable of discriminating between different physical stimuli so as to give rise to the sensory order that we actually experience (Hayek 1952: 2-8, 13-19, 37-40).

For Hayek, the human central nervous system consists of a hierarchical network of interconnected nerve fibres. Each neuron is connected to many—but not all—others by means of linkages known as axons, so that the nervous system has structure in which the position of any one neuron is defined by its connections to other nerve fibres. Neurons can generate outgoing electrical impulses (or 'firings') if they are stimulated sufficiently by incoming impulses, and it is through the transmission of such impulses that connected neurons interact with each another (Hayek 1952: 42, 55-64). On Hayek's account, it is the structure of the connections between the nerve fibres that governs people's cognitive processes and which accounts for the key features of our mental experiences (Hayek 1952: 12). The (primary) nerve impulse generated by a particular external stimulus will in turn stimulate neurons connected to those along which that primary impulse is transmitted. In this way, the external stimulus leads to the generation within the central nervous system of an induced pattern of (secondary) nerve impulses, characteristic not only of the external stimulus currently being experienced but also of the other external stimuli that have typically accompanied it in the past. Hayek refers to this train or wake of (secondary) impulses as the *following* of the initial nerve impulse. And the notion of a 'following' is significant because it is by classifying external events according to the extended pattern of nerve firings or followings they trigger that the central nervous system differentiates them from each other and thereby creates distinct sensory data. Two external events are classified as the same, and are experienced as having the same sensory qualities, if they stimulate the same configuration of neurons and so trigger an identical set or neural events or following (Hayek 1952: 48-54, 62-78).

For Hayek, then, the human mind is a vast network of interconnected neurons that acts as an instrument of classification, discriminating between incoming stimuli and thereby creating the sensory qualities we experience (Hayek 1952: 16, 35). "What we call 'mind'," Hayek (1952: 16) writes, "is thus a particular order of a set of events taking place in some organism and in some manner related to but not identical with the physical order of events in the environment."⁸ It is

⁸ We shall elaborate on this point below, when we consider Hayek's reflections on the account of the relationship between mental and physical phenomena to which his theoretical psychology gives rise.

against this background that Bertalanffy's influence on Hayek's theoretical psychology can be understood.

3.2 Bertalanffy's influence on Hayek's Theoretical Psychology

The first reference to Bertalanffy in Hayek's published writings comes in chapter 2 of *The Sensory Order*, in a section where Hayek is discussing what he means by the definition of the mind, quoted immediately above, to which his theory gives rise. In a series of four paragraphs (2.27-2.30), Hayek elaborates on his account of the nature of the relationship between mental and physical events by drawing on Bertalanffy's work.⁹ The first of the four paragraphs begins as follows:

The apparent paradox that certain relations between non-mental events should turn them into mental events resolves itself as soon as we accept the definition of the mind as a peculiar order. (Hayek 1952: 46.)

This sentence refers to the relationship between mental and physical events (that is, to the mind-body problem). Hayek elaborates on how that relationship can be understood by alluding to the notion of structural or emergent properties:

Any individual neural event may have physical properties which are similar or different from other such events if investigated in isolation. But, irrespective of the properties which those events will possess by themselves, they will possess others solely as a result of their position in the order of inter-connected neural events ... [A]n order of events is something different from the properties of the individual events ... [T]he peculiar properties of the elementary neural events which are the terms of the mental order have nothing to do with that order itself. What we have called physical properties of those events are those properties which will appear if they are placed in a variety of experimental relations to different other kinds of event. The mental properties are those which they possess only as a part of the particular structure and which may be largely independent of the former ... That a particular order of events or objects is something different from all the individual events taken separately is the significant fact behind the endless and unprofitable talk about 'the whole being greater than the mere sum of its parts'. Of course an order does not arise from the parts being thrown together in a heap, and one arrangement of a given set of parts may constitute something different from another arrangement of the same set of

⁹ Hayek also references the work of the English philosopher of biology, Joseph Woodger (1929), who—like Bertalanffy—discusses emergent properties and levels of organisation. Given that references to Woodger are less extensive than those to Bertalanffy in Hayek's writings, and given too that Hayek almost certainly came across Woodger's work through his reading of Bertalanffy, he will not be discussed further here. For more, see Lewis (2015b).

parts. An order involves elements *plus* certain relations between them ... [I]t is only when we understand how the elements are related to each other that the talk about the whole being more than the parts becomes more than an empty phrase. All that theoretical biology has in this respect to say on the significance of structural properties as distinct from the properties of the elements, and about the significance of ‘organization’, is directly applicable to our problem. (Hayek 1952: 46-47.)

Hayek distinguishes here between the physical properties of neural events—that is, of nerve firings—and their mental properties. The physical properties, he tells us, are those that neural events possess in isolation (“by themselves”). Hayek distinguishes such physical properties from the mental properties of neural events, such as their capacity to give rise to certain kinds of sensory experience. The mental properties of neural events, he tells us, arise only when people’s nerve fibres, and the neural events to which they give rise when they fire, form part of a set or order of “inter-connected neural events”. More specifically, as we have seen, it is only because people’s nerve fibres are organised into a structure such that some stimuli gave rise to different ‘followings’ that discrimination between stimuli, classification and, therefore, sense perception are possible. As Hayek puts it, “The mental properties [of neural events] are those which they possess only as part of the particular structure ... we call mind” (1952: 47; also see p. 53).

In the second half of the passage reproduced above, Hayek discusses in more detail the nature of these mental properties, and their relations to physical (neural) events, stating that, “All that theoretical biology has in this respect to say on the significance of structural properties as distinct from the properties of the elements, and about the significance of ‘organization’, is directly applicable to our problem.” The significance of this appeal to ‘structural properties’ and ‘organisation’ is of course that it indicates that, for Hayek, mental properties are emergent properties that arise only when people’s neurons are organised into a structure of the kind described above. Hence Hayek’s remark that the mental order “does not arise from the parts being thrown together in a heap” but rather “involves certain elements plus certain relations obtaining between them”.

It is worth noting at this juncture that the material contained in the four paragraphs in question cannot be found in an earlier manuscript version of *The Sensory Order*, namely *What is Mind?* (Hayek 1945).¹⁰ It appears, therefore, that Hayek added these paragraphs between

¹⁰ The origins of *The Sensory Order* are to be found in a paper Hayek wrote as a student in 1920, entitled *Beiträge zur Theorie der Entwicklung des Bewusstseins*, or “Contributions to a Theory of How Conscious Develops” (Hayek 1920). This paper contains most of the key elements of the theoretical psychology set out in *The Sensory Order* (Lewis 2015a: section 3.1). However, while Hayek felt that he had been able to set out the key principles of his theoretical psychology in that early essay, it was not until after he had resumed work on his manuscript in the late 1940s that he was able (a) to state clearly and precisely the problem addressed by his theory and also (b) to derive in a reasonably complete fashion the theory’s broader philosophical implications. More specifically, so far as issue (a) is concerned, it was only after reading the work of the gestalt psychologists in the 1940s that Hayek was able to define the terms ‘mind’ and ‘body’ in such a way as to show precisely how his theory bore upon the age-old problem that falls under the “traditional heading ... of the ‘relation’ between mind and body, or between mental and physical events” (1952: 1; also see Hayek 1994: 138) (De Vecchi 2003: 140-47; also see Lewis 2015a: section 4). The principal significance of Bertalanffy’s work for Hayek’s theoretical psychology concerns issue (b), lying—it will be argued below—in how it afforded Hayek a set of concepts—such as the notions of (levels of) ‘organisation’, of ‘structural’ or ‘emergent’ properties, and of ‘systems’—that enabled him to articulate the wider philosophical significance of his account of the mind as a relational order. Moreover, as we shall also see, in providing Hayek with the conceptual tools required to articulate, at a high level of abstraction, the nature of the human mind (viewed as a relational order),

drafting *What is Mind?* in 1945 and completing the final manuscript of *The Sensory Order* in 1952. Significantly, correspondence between Bertalanffy and Hayek indicates that Hayek read the German version of Bertalanffy's 1952 book in 1947, and that Hayek sent Bertalanffy a copy of the manuscript for *The Sensory Order* in April 1950. Bertalanffy sent his comments on the manuscript to Hayek in June of the same year (Hayek Archive Box 12, folder 4; Bertalanffy Archive letter B50; also see Hayek 1952: viii-ix). Moreover, in a footnote situated at the end of the paragraphs in question, Hayek refers to the German version of Bertalanffy's *Problems of Life* (1952), in which Bertalanffy uses the notion of emergent properties, and its correlates such as 'levels of organisation', to clarify various issues in theoretical biology and gestalt psychology. In addition, both the bibliography of *The Sensory Order* and also correspondence between the two men indicates that Hayek also read some of Bertalanffy's other writings, mostly notably his 1950 *British Journal for the Philosophy of Science* paper on systems theory, where Bertalanffy discusses structural or emergent properties and levels of organisation in terms that closely resemble those used by Hayek, during the period when he was writing the final manuscript of *The Sensory Order* (Bertalanffy 1950a; Hayek 1952: 195). The fact that the four paragraphs in which Hayek develops these ideas were added to the manuscript of *The Sensory Order* only after the initial draft of *What is Mind?* was written, taken together with the fact that the works by Bertalanffy referenced by Hayek contain accounts of the very concepts and ideas—in particular the notions of internal relations, organisation, and structural properties—that Hayek himself discusses in the passages, often using similar terminology to Bertalanffy, indicates that the addition of these passages is attributable to the influence of Bertalanffy.¹¹

What we can see here, then, is Hayek drawing on Bertalanffy's work in order to explain the account of the relationship between mental and physical events—that is, the relationship between mind and body—implied by his theoretical psychology. On this line of interpretation, Hayek drew on Bertalanffy's work in order to give an account of the philosophical significance of his theoretical psychology. In particular, as we have seen, Hayek portrays mental phenomena, not as consisting of distinctive 'mental stuff' that exists independently of the physical and biological world, but rather as a structural or emergent property of the structured array of neurons found in the human brain. Such a position is variously known within the literature on the philosophy of mind as an example of non-reductive materialism or property dualism (cf. Bunge 1980: 6-9, 21-25; Sawyer 2002: 4-7; Haraway 2004: xii, xix, 62; Allen 2005: 261, 266-67). It will be referred to below by the first of those terms. It is materialist in the sense that it portrays

Bertalanffy's ideas also constituted a set of abstract concepts that could be—and indeed, as we shall see, were—used by Hayek to identify and highlight the commonalities between the mind and other relational orders such as the market. In doing so, Bertalanffy's work helped Hayek to articulate and develop his insight that spontaneous orders are ubiquitous, being found in many parts of the natural and social world (Caldwell 2014: 2, 24-25, 35; Lewis and Lewin 2015).

¹¹ This claim should not be taken to imply that the role played by the notion of emergence in particular in Hayek's theoretical psychology is solely attributable to Bertalanffy. First, as already noted, in writing the passage from *The Sensory Order* discussed above, Hayek also drew on the work of Bertalanffy's fellow organicist biologist Joseph Woodger. Second, and more importantly, the notion of emergence had been apparent in Hayek's theoretical psychology long before he read Bertalanffy, entering into his thought as early as the *Beiträge* (via the work of the German psychologist Wilhelm Wundt) and also later through his reading of the gestalt psychologists. What Hayek's reading of Bertalanffy did, then, was to enable him to refine and articulate his understanding of emergence in a clearer and more sophisticated way (rather than prompt him to use the concept for the first time) (Lewis 2015b).

the brain as consisting, ultimately, of nothing more than physical matter; but it is non-reductive nevertheless because it suggests that the structured interaction between those physical particles gives rise to distinctive, ontologically irreducible mental properties (hence, *property* dualism).¹²

3.3 The Interpretive Significance of Bertalanffy's Ideas for Understanding Hayek: Appreciating The Philosophical Implications of Hayek's Theoretical Psychology

The significance of this interpretation of Bertalanffy's influence on Hayek is underlined towards the end of *The Sensory Order*, where Hayek draws out some of the implications of his theory of the mind for various philosophical issues. In particular, in paragraphs 8.40-8.43, which like those quoted in the previous section were added to Hayek's manuscript only after *What is Mind?* had been drafted, Hayek discusses the topics of dualism and materialism in the philosophy of mind, writing as follows:

8.40. Because the account of the determination of mental qualities which has been given here explains them by the operation of processes of the same kind as those we observe in the material world, it is likely to be described as a 'materialistic' theory. Such a description in itself would matter very little if it were not for certain erroneous ideas associated with the term materialism which not only prejudice some people against a theory thus described but, what is more important, would also suggest that it implies certain conclusions which are almost the opposite of those which in fact follow from it. In the true sense of the word 'materialistic' it might even be argued that our theory is less materialistic than the dualistic theories which postulate a distinct mind 'substance'.

8.41. The dualistic theories are a product of the habit, which man has acquired in his early study of nature, of assuming that in every instance where he observed a

¹² Perhaps unsurprisingly, this aspect of Hayek's work has eluded many commentators, both early and more recent. For instance, in a review of *The Sensory Order*, the historian of psychology Edwin Boring pointed out what he thought was an inconsistency in Hayek's argument, namely that, "all through this discussion Hayek talks like a mind-body dualist and yet presently insists that he is not" (Boring 1953: 183). The point, of course, is that Hayek is a *property* dualist, not a *substance* dualist. The fact that Hayek's property dualism is grounded in a non-reductive materialism that he leaves largely implicit is, of course, one reason why commentators such as Boring found it so hard to appreciate. More recently, De Vecchi has argued that "Hayek must confine himself to rejecting the dualism between mind and body but also from an ontological point of view ... [not] on the gnoseological [i.e., epistemological] level, that is, the level of the 'scientific explanation' of events (Hayek 1952, 4, 173, 179)" (De Vecchi 2003: 146). Again, the point is that while Hayek does reject the substance version of ontological dualism, an appreciation of the importance of emergence in his thinking makes it possible to see that he does retain a commitment to another form of ontological dualism, namely property dualism. In a similar vein, Birner describes Hayek's theoretical psychology as an example of "physicalist reductionism" and goes on to argue that, "What is perhaps most surprising of all about Hayek's psychology in the wider sense of the word, that is, comprising his solution to the mind-body problem, is that in the end it undermines his entire system of thought, except, perhaps, for his economics, which did not undergo its influence. On further analysis, Hayek's physicalist reductionism turns out to be a straightjacket that leaves no room for any active and creative role of man" (1999: 50, 78). The analysis of Hayek's cognitive psychology presented here suggests that Birner is mistaken and that there is no contradiction between his emergence-based perspective on the mind-body problem and his wider social and economic theory. For if, as argued here, Hayek's account is one in which the relationship between mind and body is best thought of in terms of the notion of emergence, then one can think of the causal powers of human mind—including not only its capacity to generate the phenomenal world of sensory experience but also its ability to imbue events with subjective meaning and to initiate novel courses of action—as emergent properties of the structured array of neurons found in the human brain and, therefore, as being quite compatible with Hayek's cognitive psychology (cf. Lewis 2012: 372).

peculiar and distinct process it must be due to the presence of a corresponding peculiar and distinct substance. The recognition of such a peculiar material substance came to be regarded as an adequate explanation of the process produced.

8.42. It is a curious fact that, although in the realm of nature in general we no longer accept as an adequate explanation the postulate of a particular substance possessing the capacity of producing the phenomena we wish to explain, we still resort to this old habit where mental events are concerned. The mind ‘stuff’ or ‘substance’ is a conception formed in analogy to the different kinds of matter supposedly responsible for the different kinds of material phenomena. It is, to use an old term in its literal sense, the result of a ‘hylomorphic’ manner of thinking. Yet in whatever manner we define substance, to think of mind as a substance is to ascribe to mental events some attributes for whose existence we have no evidence and which we postulate solely on the analogy of what we know of material phenomena.

8.43. In the strict sense of the terms employed an account of mental phenomena which avoids the conception of a distinct mental substance is therefore the opposite of materialistic, because it does not attribute to mind any property which we derive from our acquaintance with matter. In being content to regard mind as a peculiar order of events, different from the order of events which we encounter in the physical world, but determined by the same kind of forces as those that rule in that world, it is indeed the only theory which is not materialistic.

Taken at face value, these passages seem rather puzzling. In particular, how can it be, as Hayek argues in Paragraph 8.40, that a theory which tries to account for mental phenomena in terms of physical processes be *less* materialist than one which postulates a distinct mental substance? In a similar vein, what does Hayek mean when he states in paragraph 8.43 that an explanation of mental phenomena which does not postulate a distinct mental substance is the *opposite* of materialistic?

These passages become much more intelligible once they are read against the background provided by the work of Bertalanffy, and his efforts to use the notions of organization and emergence to overcome the mechanism-vitalism controversy and thereby to develop an emergentist account of biological phenomena. The problem that bedevils both mechanism and vitalism, Bertalanffy and Hayek argue, is that both approaches view the material world as being essentially atomistic in nature. On this view, physical particles only enter into external relations with one another; their properties remain unchanged by the relations in which they are involved. The possibility that physical particles might enter into internal relations with each other and thereby form organised structures—such as the human brain—that have their own distinctive (emergent) properties is therefore ruled out of court not only by mechanism but also, because it shares the same underlying atomistic worldview, by vitalism. As the historian of biology Donna Haraway has put it, Bertalanffy “saw vitalism as part of the mechanistic paradigm rather than opposed to it because both were limited by the same images and metaphors,” in particular by the

fact that in the case of vitalism the atomistic worldview “is not challenged by a wider meaning of organization or by a refusal to operate from the additive perspective” (Haraway 2004: 38, 28; also see pp. 26-29, 38-39, 61-63, 118, 137). In Bertalanffy’s words:

[I]t is the defect of vitalism that it does not free itself properly from mechanism... [B]oth mechanism and vitalism rest on the [atomistic] machine theory, they only differ in the kind of hypothetical entities they choose to assume in order to meet its deficiencies. The only way out is to reject this analogy as a sufficient basis for biological theory. (Bertalanffy 1933: 44-45; also see pp. 98, 188.)

Bertalanffy’s goal in developing organicism was to transcend the commitment to an atomistic worldview that was common to the mechanistic and vitalistic approaches. He did so by invoking the notions of structural or emergent properties, and levels of organisation, to carve out the conceptual space for a non-reductionist materialist, or emergentist, perspective on the relationship between the physical, biological, and mental worlds (Bertalanffy 1933: 28-32, 50, 62, Bertalanffy 1952: xi, 9-22, 170-71) (Hammond 2003: 36-40, 103-05, 111-15; Haraway 2004: xi-xii, xix, 19, 26-29, 38-39, 61-63, 137, 176-77).

Viewed against this background, the meaning of the passages from *The Sensory Order* quoted above can now be clarified and the two questions posed after the quotation answered. First, when Hayek writes in paragraph 8.40 that, “In the true sense of the word ‘materialistic’ it might even be argued that our theory is less materialistic than the dualistic theories which postulate a distinct mind ‘substance’”, his point is that what one might call ‘true materialism’ is not the same as ‘atomism’; by acknowledging the possibility that micro-physical particles can become organized into ordered structures that exhibit emergent (mental) properties (say), one can acknowledge that there is more to mind than (mere, atomistic) microphysical particles without having to postulate a “distinct mind ‘substance’.” This approach is “less materialistic” than that adopted by mechanism and vitalism precisely because it avoids the atomistic picture of the material world presupposed by those perspectives, a worldview whose shortcomings drove the vitalists in particular into postulating the existence of distinctive mental ‘stuff’.¹³ It is also telling in this respect that, writing in the Epilogue to the third volume of *Law, Legislation and Liberty*, in a remark to which we shall return below, Hayek acknowledges explicitly the significance of Bertalanffy’s non-reductionist materialism, writing that the efforts of Cartesian

¹³ It is also worth noting that, in a 1947 letter to Hayek, Bertalanffy responds to an earlier—alas, unseen—letter from Hayek who, having read some of Bertalanffy’s work on systems theory, had commented on the similarities between ‘vitalism’ in biology and ‘wholism’ in sociology. At the very least, this indicates that Hayek was familiar both with the vitalism-mechanism debate at the time when he was working on *The Sensory Order*, and also with the scope for ‘organismic’ approaches that emphasised the importance of organising relations and structural properties to transcend this opposition. Bertalanffy writes as follows: “I am delighted that you are interested in my ‘systems theory’, and I am very much looking forward to discussing this in more detail. Even your preliminary remarks regarding sociology and economics are highly valuable to me. I can see that, terminologically, I have to be far more careful in these matters, even though I am sure that we are entirely of one mind on the issue itself. Particularly important to me is your advice on the terms ‘individualistic’ and ‘liberalist’, as is your note that the mystical ‘holism-concept’ in sociology logically equates to ‘vitalism’. On the other hand, I expect that one will be able to define the matter in such a way that ‘organisation’ (and ‘over-organisation’) actually signify roughly the opposite of the regular meaning, that is ‘mechanisation’ of social life ... An edifying example of the expression itself running counter to the actual situation. Do please keep the copy of ‘Theoretical Biology’ as long as you would like” (Hayek Archives, Bertalanffy 12-4 box). I am very grateful to Eva Peters for translating Bertalanffy’s letter from the original German.

dualists and vitalists “to account for one unexplained order by analogy with another equally unexplained, has now been replaced by system theory, originally developed by yet another Viennese friend, Ludwig von Bertalanffy, and his numerous followers. This has brought out the common features of those diverse complex orders which are also discussed by information and communication theory and semiotics” (1979: 158-59; also see Hayek 1973: 31).¹⁴ Second, when Hayek writes in paragraph 8.43 that his account of mental phenomena is the opposite of materialistic precisely because it does not attribute to mind properties possessed by material substances, his point is that his account portrays mental properties as emergent properties of the structured arrangement—“the peculiar order”—of neurons found in the human brain. Therefore, like all emergent properties, the (mental) properties possessed by an emergent ‘whole’ such as the mind are quite different from the (material) properties possessed by the constituent parts (in this case, the individual nerve fibres) of which that whole is composed.

It appears, therefore, that in the late 1940s, Hayek read the works of Bertalanffy and, through doing so, was able to develop his appreciation of how the organisation of elements in a structure in which they stand in certain relations to one another can give rise to structural properties that are quite distinct from the properties of those elements taken in isolation. More specifically, as argued above, Hayek’s theoretical psychology is an example of non-reductive materialism, whereby mental phenomena are viewed as an emergent property of the structured array of neurons found in the human brain. And as both the opening sentence of paragraph 2.27 of *The Sensory Order* and also our reading of paragraph 8.40-43 suggests, this enabled Hayek to come up with an effective way of conceptualising the nature of the mind-body relationship, the task of understanding which was something that Hayek had come to view as the problem to which his account of the mind in *The Sensory Order* was in fact the solution.

Hayek mentions Bertalanffy’s notion of a ‘system’ only once in *The Sensory Order* (see Hayek 1952: 83, to which reference we return below). However, he does explicitly deploy that concept in one of his other, unpublished papers on theoretical psychology, on which he was working in the early 1950s. The paper in question is entitled, ‘Within Systems and About Systems’ (Hayek n.d.). In it, Hayek attempted to develop the theoretical framework set out in *The Sensory Order* into a general theory of communication between two systems, each of which is a classificatory apparatus of the kind described in his work on theoretical psychology. The influence of Bertalanffy can be seen in this unfinished manuscript, with Hayek explicitly stating that, “The term system will ... be used here in the sense in which it is used in von Bertalanffy’s ‘General System Theory,’” that is “in the sense of a coherent structure of causally connected physical parts” (Hayek n.d.: 4).¹⁵ Systems of this kind, Hayek continues, are “organised” into “a structure” that has a “hierarchy of levels” (pp. 5, 7, 10). What this demonstrates is that Hayek was aware of, and was using, Bertalanffy’s concept of ‘system’ in the early 1950s. This will turn

¹⁴ In a footnote accompanying this passage, Hayek (1979: 200 n. 33) references Bertalanffy’s 1969 book on systems theory.

¹⁵ In a footnote on the same page, Hayek writes, “L. von Bertalanffy, 19” (Hayek n.d.: 4 n. 3). The absence both of a date for the Bertalanffy reference, and also of a bibliography in Hayek’s manuscript, makes it hard if not impossible to be sure which Bertalanffy essay or book Hayek was drawing on. Given, however, that Bertalanffy offers definitions of ‘system’ consistent with that used by Hayek in several places, the absence of a precise reference is probably unimportant (see for example, Bertalanffy 1950: 143, 1952: 11).

out to be significant when we consider, in the next section of the paper, how Bertalanffy's ideas helped to shape Hayek's thinking in the 1950s and 1960s, not on the topic of theoretical psychology, but on economics and social theory.

3. THE INFLUENCE OF BERTALANFFY II: HAYEK'S ECONOMICS

We move on now to consider Hayek's writings on the problem of social order, in particular his answer to the question—which he first posed in his 1937 paper, 'Economics and Knowledge' ([1937] 2014)—of how order arises in decentralised market economies when the knowledge required for people to form mutually compatible plans is dispersed throughout the economy as a whole. Hayek first made significant progress towards answering this question in his 1945 paper on 'The Use of Knowledge in Society' ([1945] 2014). He argued there that, when individuals form and implement plans based on their knowledge of their local circumstances, they generate changes in relative prices that afford other people an indication of that knowledge, enabling them to amend their plans so as to take that knowledge into account even though they are not directly aware of it (Hayek [1945] 1948: 83-90). However, as Hayek hints in his 1945 paper (see [1945] 1948: 88), and as he argues more systematically and explicitly in his later writings on the political theory and the philosophy of law, plan coordination is facilitated not only by the information conveyed by relative price signals but also by the knowledge provided by various social norms and rules (including both the formal legal rules of property, tort and contract law, and also by informal norms of honesty and promise-keeping). The fact that people act in accordance with the same general guidelines about how to interpret and respond to circumstances of various kinds helps them to form reasonably accurate expectations of each other's conduct, thereby enabling them to devise plans that have a reasonable chance of coming to fruition. Perhaps most notably, by facilitating enforceable contracts, legal rules enable people to formulate and embark upon plans of action confident that the contributions that other people must make for those plans to be brought to a successful conclusion will actually be forthcoming (Fleetwood 1995; Vaughn 1999b).¹⁶

The significance of all this for our present purposes is that, especially from the early 1960s, Hayek's efforts to articulate and develop his insights into the working of the market economy were informed and shaped, at least in part, by Bertalanffy's work. During this period, Hayek was attempting to reformulate his ideas about economic theory so that they incorporated his developing understanding of complex phenomena (Caldwell 2004: 297-306, 2014). What is especially noteworthy for the argument being advanced here is that, as Hayek wrote to Karl

¹⁶ As Hayek puts it in *Law, Legislation and Liberty*, "What makes men members of the same civilization and enables them to live and work together in peace is that in the pursuit of their individual ends the particular monetary impulses which impel their efforts towards concrete results are guided and restrained by the same abstract rules. If emotion or impulse tells them what they want, the conventional rules tell them how they will be able and be allowed to achieve it" (Hayek 1976: 12; also see Hayek [1968] 1968: 72).

Popper in 1960, he was attempting to restate his insights into the working of the economy using “the conception of higher-level regularities”, adding that:

I suspect it is really what Bertalanffy with his General Systems Theory was after and the conception itself was of course already implied in my “Degrees of Explanation.” It continues to become clearer, though I have not yet got an altogether satisfactory formulation of what I am after. (Hayek to Popper, February 27th 1960, Hayek Collection, box 44, folder 2, Hoover Institution Archives, quoted in Caldwell 2014: 18.)¹⁷

Elsewhere in the same letter, Hayek writes of his efforts that: “Though I do not mean to concentrate mainly on methodology, The New Look at Economic Theory which I am taking and which may result in a book of that title inevitably began with an attempt to restate my views on the nature of economic theory, and the conception of higher-level regularities which I then formed continues to occupy me and seems fruitful far beyond the field of economics” (quoted in Kresge 1994: 28).¹⁸ The allusion to ‘A New Look at Economic Theory’ is a reference both to a book on economics that Hayek was planning to write in the late 1950s and also to a set of lectures he delivered at the University of Virginia in 1961. In a section of the lectures entitled, “Higher Level Regularities”, Hayek discusses how such regularities describe the “general character of an order”, in particular the fact that in such an order there will obtain “certain relations between its parts.” He does not, however, develop the idea in much more detail in those lectures, beyond pointing out the limitations of the knowledge social scientists are likely to be able to obtain about such systems (Hayek [1961] 2014: 381-82).¹⁹

A more significant attempt to use Bertalanffy’s ideas to understand the economy can arguably be found in Hayek’s important 1967 essay, ‘Notes on the Evolution of Systems of Rules of Conduct’ ([1967a] 2014). Although he does not mention Bertalanffy by name, Hayek in that essay employs Bertalanffy’s notion of a ‘system’, and his distinction between different levels of reality, to express the idea that the coordinative power of the market economy is an

¹⁷ In his 1955 essay on ‘Degrees of Explanation’, Hayek mentions “general system theory”, along with cybernetics and the theory of automata, as one of the recent intellectual developments exploring complex phenomena ([1955] 2014: 211).

¹⁸ The notion that reality is hierarchical, displaying distinct ‘levels of organisation’, was, as we have seen, a notable feature of Bertalanffy’s work. Additional evidence of Hayek’s interest in this idea can be found in the form of teaching notes he produced for a seminar class on “Scientific Method and the Study of Society”, held at the University of Chicago in late 1952. These included a chart listing phenomena at different “levels of organisation”—the very title of chapter 2 of Bertalanffy’s *Problems of Life* (1952: 23)—ranging from the gene to the cell to individuals to society, along with the corresponding fields of study (genetics, physiology, etc.) (see Hayek Archive, Box 63, folder 13; also see Caldwell 2004: 298-99). The distinction between these different levels of organisation, coupled with the fact that in Hayek’s chart each is allocated its own field of study, suggests that Hayek followed Bertalanffy in viewing the world as hierarchical in nature, with entities at lower levels of organisation forming the building blocks out of which higher-level entities, possessing their own higher-level or emergent properties, are formed. As Hayek later puts it, “Societies differ from simpler complex structures by the fact that their elements are themselves complex structures” ([1967a] 2014: 288).

¹⁹ See Caldwell (2014: 16-19) for a discussion of the book project to which Hayek refers and to the Virginia lectures.

emergent property, or higher-level regularity, that arises when people's (inter)actions are governed and structured (organised) by particular sets or systems of rules.²⁰

Hayek argues first of all that the coordinative power of the price mechanism, which he christens “the overall order of actions”, is an emergent property that arises when people's interactions are structured by a set of rules that includes both formal legal rules and informal social norms (Hayek [1967a] 2014: 282). It is an emergent property because it is possessed only by a particular “whole” (p. 282), namely the free market economy that is formed by a group of people whose interactions are governed by a set of rules of that kind:

The overall order of actions in a group is ... more than the totality of regularities observable in the actions of the individuals and cannot be reduced to them ... It is more than the mere sum of its parts but presupposes also that those elements are related to each other in a particular manner. (Hayek [1967a] 2014: 282.)²¹

Hayek underlines the emergent nature of the overall order of actions later in the paper, arguing that in such cases “some regularity in the behaviour of the elements produces ... a wholly different regularity in the actions of the whole” that “cannot be ... reduced to the regularities of the parts” (pp. 289, 286).²² In the first place, then, Hayek employs the idea of ‘higher-level’ regularities, derived from Bertalanffy, to develop and articulate his view that the coordinative power of the market is an emergent property that is irreducible to the ‘lower-level’ properties of individual people.²³

²⁰ Hayek does show that he is aware of Bertalanffy's notion of a system, both in *The Sensory Order* (1952: 83) and also in ‘Within Systems and about Systems’ (n.d.: 4).

²¹ In Hayek's view, it is precisely because statistics “treats the individual elements which it counts as if they were not systematically connected” and so “deliberately disregards the fact that the relative position of the different elements in a structure may matter” that statistics is incapable of advancing the understanding of social order ([1964] 2014: 265).

²² Elsewhere in the essay, Hayek underscores the irreducibility of the emergent power to coordinate people's actions by noting that “it is at least conceivable that the same overall order of actions may be produced by different sets of rules of individual conduct”. It is possible to make sense of this possibility, Hayek contends, only by acknowledging that “the system of rules of individual conduct and the order of actions that results from the individuals acting in accordance with them are not the same thing” (that is, by acknowledging the existence of an ontological distinction between rules and individual actions, on the one hand, and the emergent power to coordinate people's plans, on the other) (Hayek [1967a] 2014: 279, 287-79; also see Hayek [1966] 1968: 169). Hayek makes a similar point in *The Errors of Constructivism*, writing that, “The order of society is therefore a factual state of affairs which must be distinguished from the regularity of the conduct of individuals” ([1970] 2014: 344).

²³ There is no evidence that there was any correspondence between Hayek and Bertalanffy in the 1960s. However, the two men did attend some of the same conferences. First, in June 1960, both attended the ‘Symposium on the Principles of Self-Organization’, sponsored by the Information Systems Branch of the US Office of Naval Research and held at the University of Illinois. However, neither Hayek nor Bertalanffy presented a paper and the few references to them in the conference's Transactions are devoid of intellectual content (see Foerster and Zopf [eds.] 1962, pp. x, 132, 261, 382, 283, 399). Second, and more significantly, both men participated in the 1968, at Alpbach symposium, so called because it was held at Alpbach in the Austrian Tirol. The participants in the symposium, which was organised by the writer Arthur Koestler, were concerned to remedy “the insufficient emancipation of the life sciences from the mechanistic concepts of nineteenth century physics, and the resulting crudely reductionist philosophy” (Koestler 1969: 2). Accordingly, they shared a common interest in exploring the potential of the organismic paradigm, with its emphasis on organization, emergence, and the hierarchical ordering of the natural and social worlds, in variety of different disciplinary contexts. Indeed, in addition to Hayek and Bertalanffy, participants in the 1968 symposium included another of the principal architects of organismic biology, namely the Viennese developmental biologist Paul Weiss (Haraway 2004: 4-5, 15-16, 38, 131-33, 183-84). The paper Hayek presented at the symposium was ‘The Primacy of the Abstract.’ Frustratingly, and tantalisingly, for the purposes of the present essay, the first footnote in the version of the paper published in the conference proceeding contains the following comments from the editors of the volume: “On the original programme of the conference, Professor Hayek was scheduled to give a paper on ‘Group Behaviour and Individual Behaviour’ and the applications of the hierarchic concept in the social sciences. In the preamble to his presentation, he explained why he preferred to talk on ‘The Primacy of the Abstract’ instead. This also explains why, except for references in passing, social science in the narrower sense was not discussed at the Symposium. *Eds.*’ (Koestler and Smythies [eds.] 1969: 309 n.1). The editors' comments were, perhaps unsurprisingly, excised from the

Moreover, this emergent property is generated by a *system* of rules in Bertalanffy's sense of that term. That is to say, for Hayek, the emergent property, the overall order of actions, is the result of the causal *interaction* of several different rules, rather than being simply the *sum* of their separate effects. We can see this "most clearly in Hayek's remark that, "[S]ystems of rules of conduct will develop as wholes" ([1967a] 2014: 283):

The evolutionary selection of different rules of individual conduct operates through the viability of the order it will produce, and any given rules of individual conduct may prove beneficial as part of one set of such rules, or in one set of external circumstances, and harmful as part of another set of rules or in another set of external circumstances. (Hayek [1967a] 2014: 280; also see p. 73 and Hayek 1973: 59-61, 1979: 167, as well as Hayek [1962] 2014: 246.)

Just as Bertalanffy argues that the elements of a system behave differently when they are part of that system compared to when they are in isolation, thereby giving rise to emergent, system-level properties, so Hayek analogously contends that the rules in terms of which social systems are defined have a different impact on social outcomes depending on the other rules with which they interact. On Hayek's account, therefore, there is an intricate rule structure, with certain rules complementing each other in the sense that, taken together, they give rise to emergent capacities that are not possessed by any of them taken alone. For example, as noted above, the existence of the overall order of actions requires both formal legal rules and also informal moral rules; one of those types of rules alone will not suffice to generate the overall order of actions (Hayek 1960: 36, 158). And it is this insight—that the outcomes to which sets of complementary rules give rise are emergent, rather than additive—which Hayek attempts to capture using the notion of 'system'. Hayek's discussion of rule systems of can thus be seen to be a specific instance, or application, of Bertalanffy's concept.²⁴

version of the paper that was published in Hayek's 1978 volume, *New Studies in Politics, Philosophy and Economics* (Hayek [1969] 1978: 35). Nor do they appear in the version of the essay reprinted as in Hayek's *Collected Works* (Hayek [1969] 2014). One can, of course, speculate that had Hayek written on the topic intended for him, he would have presented a variation on, or development of, his 1967 paper, 'Notes on the Evolution of Systems of Rules of Conduct', which is—as we have seen—the essay in which Hayek focused most explicitly on the importance of higher-level emergent properties (as part of his account of group selection and cultural evolution) (Gaus 2006 and Lewis 2015b). But it would have been fascinating to see how Hayek might have developed that work, and to learn how his fellow conferees would have responded to his paper in the discussion that followed, given that—as already noted—there were present at the symposium several scholars who had carried out pioneering work on hierarchical levels of organisation and structural properties in biology from the 1920s onwards. As it is, the significant recorded interaction between Bertalanffy and Hayek at the symposium is limited to a debate about the merits of Darwinian evolutionary theory (see Koestler and Smythies [eds.] 1969: 79-80; also see Pouvreau 2009: 188-89).

²⁴ Hayek's use of the notion of a 'system' of rules to understand how social order is possible also informs his jurisprudence. In the latter, Hayek argues that judges should try to discover those laws that are implied by, or complementary to, the laws that are already in force, thereby helping to reinforce the prevailing system of rules and to sustain the emergent order of actions that supervenes on that rule system (Hayek 1973: 94-123, 1976: 31-44, 70-73, 1979: 157-60, 207 n. 62; also see Mack 2006). It is also noteworthy in this regard that, in discussing how systems of complementary rules are required for the emergent order of (just) actions is to obtain, Hayek contrasts his (organicist) approach with the old atomistic view of the world as a mosaic of independent, atomistic parts: "The idea that we are not fully free to pick and choose whatever combination of features we want our society to possess, or to fit them together into a viable whole, that is, that we cannot build a desirable order like a mosaic by selecting whatever particular parts we like best, and that many well-intentioned measures may have a long train of unforeseeable and undesirable consequences, seems to be intolerable to modern man" (Hayek 1979: 59; also see pp. 48, 51).

Moreover, the notion of a ‘system’ in the sense in which that concept is defined by Bertalanffy the notion of systems of rules, each of which gives rise to higher-level, emergent properties, is also important for Hayek’s attempt to deal with the next task he sets himself, namely that of explaining how a set—or, as Hayek also terms it—a “system” of rules of the kind required to generate the overall order of actions comes to prevail ([1967a] 2014: 279).²⁵ Hayek’s explanation takes the form of a theory of cultural evolution, whereby the rules in question are the product of a process of competition between different groups of people. Significantly, the groups in question are defined by reference to the system of rules to which their members subscribe, and the trait that forms the basis for the competition between those groups is the emergent property or overall order of actions to which each system gives rise. As Hayek puts it, “[W]hat may be called the natural *selection* of rules will operate on the basis of the greater or lesser efficiency of the resulting *order of the group*” ([1967a] 2014: 279):

It is the resulting overall order of actions but not the regularity of the actions of the separate individuals as such which is important for the preservation of the group ... [and] the selection process of evolution will operate on the order as a whole. (Hayek [1967a] 2014: 280, 283.)

The different sets of rules structure the actions of the members of the various groups and, in virtue of their collective capacity to underpin the emergent capacity to coordinate people’s plans, determine the success of those groups in the process of competition through which selection occurs. Those groups whose activities were structured by a set of rules that gives rise to the emergent capacity effectively to coordinate people’s actions were able to generate the wealth required to sustain higher populations, while groups that did not adhere to such rules declined in size and ultimately were eliminated. Ultimately, therefore, groups exhibiting the emergent property in question came to predominate. For Hayek, then, it is in virtue of their capacity to generate the emergent causal power to coordinate people’s actions without centralised direction that groups—and, more specifically, the systems of rules that characterise them—are selected in the process of social evolution (Gaus 2006; Lewis 2015b).²⁶

Hayek elaborates on these issues in another essay originally published in 1967, namely ‘The Results of Human Action but not of Human Design’ ([1967b] 2014). In the course of

²⁵ Also see Hayek 1973 65-67, 74-75, 96-106, Hayek 1976: 24-29, and Hayek 1979: 157-60, 207 n. 62.

²⁶ It is also noteworthy in this regard that, by the late 1960s, Hayek was applying these ideas, about group selection on the basis of the emergent properties sustained by systems of rules, back to his theoretical psychology. “[W]hat we call mind,” Hayek ([1967a] 2014: 321-22), ‘is essentially ... a system of abstract rules of action’. This system of rules, Hayek argues, evolves through a process of competition whereby systems of rules, and the groups of neurons in which those rules are embodied, are selected—or not, as the case may be—in virtue of their emergent capacity to classify the world, and to dispose people to act, in ways that enables a person successfully to navigate, his or her environment: ‘[I]t is by a selection among mechanisms producing different action patterns that the system of rules of action is built up on which rests what we regard as an interpretation of the external world by the mind ... As the organism plays with a great many action patterns of which some are confirmed and retained as conducive to the preservation of the species, corresponding structures of the nervous system producing appropriate dispositions will first appear experimentally and then either be retained or abandoned” (Hayek [1967b] 2014: 321; also see Hayek [1962] 2014: 146-47; cf. Caldwell 2004: 307). This process of neuronal group selection on the basis of the emergent properties that supervene on the system of rules governing the behaviour of the relevant group of neurons is, of course, analogous to the process of group selection that Hayek believes accounts for the development of rule-governed social systems such as the market economy.

discussing the process of cultural selection through which the system of rules that sustains the spontaneous market order or catallaxy itself emerges, Hayek argues that a key insight in the history of social theory, which he attributes to the Austrian economist Carl Menger, was the realisation that “the problem of the origin or formation and that of the manner of functioning of social institutions was essentially the same:”

[T]he institutions did develop in a particular way because the co-ordination of the actions of the parts which they secured proved more effective than the alternative institutions with which they had competed and which they had displaced. The theory of the evolution of traditions and habits which made the formation of spontaneous orders possible therefore stands in a close relation to the theory of the evolution of the particular kinds of spontaneous orders which we call organisms, and has in fact provided the essential concepts on which the latter was built. (Hayek [1967b] 2014: 298.)

Hayek adds a footnote to this passage, where he writes that, “It is interesting to compare this with the insight from the biological field stressed by Ludwig von Bertalanffy, *Problems of Life* ... p. 134”, before quoting Bertalanffy as follows:

What are called structures are slow processes of long duration, functions are quick processes of short duration. If we say that a function such as the contraction of a muscle is performed by a structure, it means that a quick and short process wave is superimposed on a long-lasting and slowly running wave. (Bertalanffy 1952: 134; quoted in Hayek [1967b] 2014: 298, n. 16.)

The passage from Bertalanffy is to be found in a section of *Problems of Life* entitled, “The System Conception of the Organism – A Basis for Exact Biology” (Bertalanffy 1952: 132-46; also see Haraway 2004: 39, 185). Bertalanffy argues in that section that the (static) study of the functions served by certain biological systems within the organism cannot be divorced from the (dynamic) processual account of how those organised systems arise and maintain themselves over time. This is, of course, analogous to the point that Hayek wishes to make with regard to social (rule) systems, namely that the (static) functional account of how certain systems of social rules underwrite the emergent capacity to coordinate people’s actions is inextricably bound up with the (dynamic) account of the process through which those systems of rules emerge over time, because it is precisely in virtue of their effectiveness in generating such a capacity that those systems come to prevail in the process of evolutionary competition.²⁷

²⁷ Another way of expressing Hayek’s point is as follows. For Hayek, while it is important and interesting to develop give a static or synchronic account of how, when people’s actions are governed by a particular system of rules, there arises the emergent property known as the overall order of actions, such analyses take the existence of the rules as given. Ultimately, therefore, they provide an incomplete answer to the question of how social order is possible in decentralised market economies, because they do not explain the origins of the requisite rule system. A fuller explanation of the possibility of order requires a dynamic or diachronic account of how the relevant system of organising rules comes to exist. As

Hayek is drawing here on Bertalanffy in support of his (Mengerian) claim that the static and dynamic aspects of the analysis of order must be combined if the possibility of market order is to be understood as fully as possible. Not for nothing does Hayek refer on several occasions to the importance of the “twin ideas of evolution and spontaneous order” (Hayek [1967a] 2014: 299; also see Hayek [1966] 1991: 81 and 1979: 158). On Hayek’s account, these two concepts intimately related because, as we have seen, he believes that it is only through an evolutionary account of the development of those systems of rules which sustain the emergent capacity to coordinate people’s actions that it is possible to obtain a satisfactory account of how the spontaneous order of the market is possible. But Bertalanffy’s contribution is arguably more significant than simply that of providing an illustration of how natural scientists engage in a form of theorising analogous to that proposed by Menger and Hayek. For some of the key components of the analytical framework in terms of which Hayek articulates and develops his Mengerian insight about the need to combine static and dynamic analysis—the conceptual glue that holds the notions of spontaneous order and evolution together, if you will—are, as we have seen, ones that Hayek obtains from Bertalanffy, in particular the notion of emergent or structural properties and the concept of a ‘system’.²⁸ What we can see here, then, is that Hayek used Bertalanffy’s ideas to express and develop Menger’s insight about the intimate connection between the origin and manner of functioning of social institutions in a modern idiom, namely the language of system theory.²⁹

It is worth elaborating on one final aspect of Hayek’s contention that cultural change proceeds via the selection of groups that adhere to systems of rules that underwrite the overall order of actions. A corollary is that groups that are characterised by rules which do not yield that emergent property will gradually wither away, as of course will their associated sets of rules. Therefore, as Hayek notes, cultural evolution can also be thought of as proceeding via the “selective evolution of rules and practices”, involving in particular the “selective elimination of less suitable conduct” (1979: 154, 1960: 26; also see 1979: 155, 157, 159). On this view, order arises from the elimination of systems of rules that are *not* conducive to order. As Hayek puts it:

Hayek puts it, while it is the case that “for the explanation of the functioning of the social order at any one time the rules of individual conduct must be assumed to be given ... these rules of conduct have themselves developed as part of a larger whole” and the existence of such wholes, or systems of rules, “can be made intelligible only by ... a theory of their evolution” ([1967a] 2014: 284, 287). And, of course, it is precisely such a theory that Hayek’s analysis of group selection is meant to provide. For more on this, see Lewis (2015a: sections 3.2-3.3).

²⁸ If this claim is correct, then it implies that those commentators—such as Vanberg (1986: 97), Paul (1988: 261), and Hodgson (1993: 177) — who have called into question the compatibility of Hayek’s work on spontaneous order with his evolutionary theory of group selection are mistaken. For excellent accounts of various influences on Hayek’s evolutionary theory other than Bertalanffy, see Caldwell (2000) and Angner (2002).

²⁹ Hence also Hayek’s remark that “for the understanding of the methodological problems of the social sciences a study of the procedures of geology or biology is much more instructive than that of physics. In all of these fields the structures or steady states ... can be fully accounted for only by considering also circumstances which are not properties of the structures themselves but particular facts of the environment in which they have developed and exist” (Hayek [1967a] 2014: 287). The reference to “steady states” found here, which is to be found in another paragraph where Hayek discusses Menger’s claim that function and evolution are intimately bound together, also reflects the influence of Bertalanffy, who used it in the section of *Problems of Life* on which Hayek drew to distinguish physical equilibria, in which the lower-levels parts as well as the higher-level structures they form remain constant over time, from biological systems such as the organism, which “persists as a whole” over time whilst being maintained in that higher-level “steady state” only through processes that involve the “continuous change, formation, growth, wearing out, and death of systems of the next lower level ... [for example] of cells in a multicellular organism” (Bertalanffy 1952: 124-25). As Bertalanffy puts it in the sentence immediately following the one cited by Hayek and reproduced in the main text, “A living organism is an object maintaining itself in an orderly flow of events wherein the higher systems appear persistent in the exchange of the subordinate ones” (Bertalanffy 1952: 134-35; also see pp. 124-136).

[N]ot every system of rules of conduct will produce an overall order of the actions of a group of individuals ... The classical instance in which the very regularity of the behaviour of the elements produces ‘perfect disorder’ is the second law of thermodynamics, the entropy principle. It is evident that in a group of living beings many possible rules of individual conduct would also produce only disorder or make the existence of the group as such impossible. A society of animals or men is always a number of individuals observing such common rules of conduct as, in the circumstances in which they live, will produce an order of actions. (Hayek [1967a] 2014: 279; also see [1966] 1968: 169, 1973: 44)

It seems likely that this passage bears the influence of Bertalanffy’s work on systems, in particular his notion of a system that is *open* in the sense of being able to import energy from its surroundings. As noted above, Bertalanffy developed this concept in order to understand how, in an apparent violation of the second law of thermodynamics, the biological world displays a tendency to produce increasingly complex and more highly organised forms of life. Significantly, Hayek had long been aware of Bertalanffy’s work on this topic, writing in *The Sensory Order* of the “recent and most promising work of L. von Bertalanffy [on] ... ‘open systems’” (Hayek 1952: 83).³⁰ It seems reasonable to conclude, therefore, that the references to thermodynamics and entropy that Hayek makes in the course of his exposition of his theory of group selection are derived from Bertalanffy’s work, constituting another way in which—and, *a fortiori*, further evidence that—Bertalanffy’s work on systems influenced Hayek’s thinking on cultural evolution.

What we can see in these two 1967 essays is that Hayek used system theory, which he had originally come across through his work on the philosophy of mind, to help him articulate ‘the common features of ... diverse complex orders’ in other domains, most notably in this case the market as an spontaneous order or catallaxy (1979: 158-59). Bertalanffy’s conceptual framework—in particular, the notions of emergent or structural properties, of distinct ‘levels’ of reality, and of (open) ‘systems’—provided Hayek with a means of expressing and developing his insights into the working of the economy, in particular by helping him to articulate his view that the market order or catallaxy rests on a system of rules that has itself arisen spontaneously, through a process of evolution centring on the capacity of those rules to generate the emergent property to coordinate people’s actions. While as Hayek often notes, the development of evolutionary biology was informed by the idea of political economists, what we see here is Hayek re-appropriating for economics the ideas developed by theoretical biologists like Bertalanffy, using the notions of ‘system’, of ‘levels of organisation’, and of ‘structural’ or ‘emergent’ properties, first of all to help him frame the nature and philosophical significance of

³⁰ In a footnote, Hayek refers to the German version of Bertalanffy’s 1952 book (Hayek 1952: 83, n. 1). In addition, the bibliography of *The Sensory Order* contains references to Bertalanffy’s 1950 *Science* article on ‘The Theory of Open Systems in Physics and Biology’ (Bertalanffy 1950b) (see Hayek 1952: 195).

his theoretical psychology, before subsequently deploying them to express his emerging understanding of the economy as a complex system. As Hayek put it in the Epilogue to the third volume of *Law, Legislation and Liberty*, “My colleagues in the social sciences find my study on *The Sensory Order* uninteresting or indigestible ... But the work on it helped me greatly to clear my mind on much that is very relevant to social theory. My conception of evolution, of a spontaneous order and of the methods and limits of our endeavours to explain complex phenomena have been formed largely in the course of work on that book. As I was using the work I had done in my student days on theoretical psychology in forming my views on the methodology of the social science[s], so the working out of my earlier ideas on psychology with the help of what I had learnt in the social science helped me greatly in all my later scientific developments” (Hayek 1979: 199-200, n. 26; also see Hayek 1979: 158).³¹

5. CONCLUSION

The argument advanced above is that Ludwig von Bertalanffy influenced the post-war work of F.A. Hayek in two related ways. First, in the late 1940s and early 1950s, Bertalanffy’s work helped Hayek to articulate the philosophical significance of his theoretical psychology, in particular the fact that for Hayek the mind is an emergent or structural property of the organised arrangement of neurons found in the human brain. The upshot is that Hayek’s theoretical psychology can be thought of as an example of non-reductive materialism.

Second, in Hayek’s hands, the conceptual framework provided by general system theory proved, as Bertalanffy intended, abstract enough to be applicable to phenomena situated at a number of different ‘levels’ of reality. In particular, having in the course of writing *The Sensory Order* used Bertalanffy’s ideas to help draw out and express some of the philosophical implications of his theory of mind, Hayek in the 1950s and 1960s applied system theory to help him analyse the working of society and thereby articulate and develop his emerging vision of the economy as a complex system. Perhaps most importantly, Hayek used the notions of a ‘system’ (of rules), and of higher level emergent properties, in particular to provide a conceptual framework and a language that enabled him to unite, in a coherent and fruitful way, the “twin ideas of evolution and spontaneous order” by which he set such great store.

Bertalanffy’s work was not, of course, the only influence that helped shape Hayek’s efforts to develop an account of the economy as a complex adaptive system. For example, the influence of Warren Weaver, in particular his distinction between organised and disorganised

³¹ There is some evidence to indicate that the influence between Hayek and Bertalanffy flowed in both directions. In his 1950 paper on systems theory, Bertalanffy references Hayek’s *Road to Serfdom* in a passage where he describes what he sees as the (then) contemporary “tendency to consider a society, an economy, or a nation, as a whole which is superordinated to its parts.” Bertalanffy continues as follows: “This conception is at the basis of all the various forms of collectivism, the consequences of which are often disastrous for the individual and, in the history of our times, profoundly influence our lives” (1950: 135). Elsewhere, Bertalanffy favourably cites Hayek’s notion of ‘explanation of the principle’ arguing that “there are degrees in scientific explanation and that in complex and theoretically little-developed fields we have to be satisfied with what the economist Hayek has justly termed ‘explanation in principle’” (Bertalanffy 1969: 36, also see 1969: 47, 113).

complexity, has been well documented (Caldwell 2014: 14-15).³² Nevertheless, the account developed above suggests that Bertalanffy too played a significant role in the development of Hayek's post-war thought. If this paper has served to make the nature of Bertalanffy's contribution clearer, then it will have served its purpose.

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³² It is worth noting that, in Weaver's (1948) account, 'organization' is understood as being present in systems which "involve dealing simultaneously with a sizeable number of factors which are integrated into an organic whole" (p. 539). After having introduced the notion of organised complexity, Weaver proceeds to discuss various possible ways of analysing those systems, such as statistics, computing, and operations research (pp. 539-42). It is noteworthy, however, that nowhere in the article does Weaver discuss the notion of emergence or its correlates, structural properties and levels of organisations. While Weaver was influential in shaping Hayek's views on complexity in general, perhaps most notably by providing a scientifically-grounded rationale for Hayek's scepticism about the usefulness of statistical methods for the study of the social world, he does not appear to have had a significant impact on Hayek's views about the way that complex systems display emergent properties. In a similar vein, the population geneticist Sewall Wright, who was one of the early exponents of group selection, who attended seminars organised by Hayek at Chicago in the 1950s, and whose work was cited by Hayek (Hayek 1979: 202 n. 37; Caldwell 200: 299, 314-15), explicitly disavowed the notion of emergence, arguing that it "can have no place in scientific analysis of the problem [of evolution]" (Wright 1931: 154).

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