

Chapter 2

Kant on the Ideal Unity of Science

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2.1. Introduction: Kant and the recent unity of science debate

Claims about the unity of science have a long history and, over the centuries, they have appeared in many different forms. Often such claims have been accompanied by visions of order and harmony, and by conceptions of the lawfulness and unity of nature. But claims to the unity of science today are probably as unpopular as they have ever been. Over the last 20 years or so, the well-known 20th-century accounts of unity that, in different ways, grew out of the logical positivist unity of science movement have come under severe criticism,¹ with philosophers of science at the forefront of this critique, promoting instead the pluralism of the sciences and the disunity of the phenomena that those sciences study.² After the prominent call for the unity of science in the 20th century, these critics have declared scientific pluralism as the reigning “consensus” in the philosophy of science and the 21st century as the century of disunity.³

In this chapter, I reconsider Kant’s views in the context of this more recent debate. Kant’s position is most well-known in the current literature for inspiring conceptions of unity as an ideal of science, a conception exemplified, for example, by the influential accounts of Philip Kitcher and Michael Friedman.⁴ But Kant’s views are not easily assimilated to these positions. I suggest in this chapter that Kant’s conception of unity as a necessary regulative ideal is importantly distinct from the more recent accounts, including those that aspire to an explicitly Kantian idea. I argue, in particular, that the Kantian conception of unity is distinct with respect to its epistemic status and its content; it has a regulative, or heuristic, status and brings with it important non-reductionist implications. (In subsequent chapters I argue, furthermore, that it is because of these distinct features that the Kantian conception has clear

¹ See, e.g., Carnap (1928), Carnap et al. (1929/1973), Neurath (1937/1983).

² In particular, Dupré (1993), Cartwright (1999), Chang (2012).

³ Mitchell (2003, 180); see also Brigandt (2010, 296).

⁴ Kitcher (1981; 1989; 1995); Friedman (1979; also 2001).

advantages over more recent notions and can offer interesting answers in response to the challenges that have recently been raised against the idea of the unity of science.)

So, what makes Kant's views distinct? To bring out the differences, let me set the scene with a brief sketch of two important alternative positions of recent ilk – one with clear differences to the Kantian approach, the other with subtler divergences.⁵ Probably the most well-known 20th century account construes the unity of science as a well-grounded empirical hypothesis. This is what I call here the *classic thesis* of the unity of science. A famous example is set out by Paul Oppenheim and Hilary Putnam in their influential 1958 paper “The Unity of Science as a Working Hypothesis.” Oppenheim and Putnam argue that the scientific evidence reveals the uniform, homogeneous, and thoroughly lawful character of nature. As evidence, they cite a variety of successful reductive projects. For instance, they point out that, in biology, the development and maintenance of cells can be explained in genetic terms; in psychology, phenomena such as memory, motivation, or emotional disorders are reduced to neuro-physiological phenomena; and in economics, group phenomena such as the market can be reductively explained in terms of the preferences, choices, and actions of individuals.

According to Oppenheim and Putnam, the evidence reveals that nature is a unity of a specific kind: higher-level entities are mereological composites of micro-level entities, and the behaviour of higher-level entities are fully explained by the laws of the micro-level. And since the results of our actual science suggest that nature is unified in this way, we should expect that our best science will, in the end, be fully unified, too. According to Oppenheim and Putnam, all fields of science will thus ultimately be reduced to some fundamental science – namely, physics.

Today, few accept the classic thesis. One important challenge has been that there is actually plenty of empirical evidence that points in the opposite direction, namely, to the disorder of nature and the disunity of science. John Dupré has argued, for instance, that the failure of attempts to explain ontogenetic processes in terms of molecular genetics or to eliminate folk-psychological laws in favour of neurophysiological laws in fact provides a significant body of empirical evidence *against* the classic unity thesis.⁶ On Dupré's account, since current science points to the disorder of nature we should expect that our best science, in the end, will be disunified, too. Furthermore, a general question arises from this criticism about the conclusiveness of these arguments. Dupré himself points out the limitations of his

⁵ I take the following summaries of the classic and unificationist theses from Breitenbach and Choi (2017).

⁶ Dupré 1993.

challenge when he notes that “no amount of . . . evidence can rule out the possibility that [the] diversity [of science] reveals only the immaturity of most of science.”⁷ More generally, it is not obvious that the structure of our best science will be revealed by purely empirical considerations.

In line with this kind of reasoning, a second account that has influenced recent debates does not ground the unity of science in the unity of nature but in epistemological considerations. One can find this approach, for example, in the work of Michael Friedman and Philip Kitcher who articulate an influential conception of the unity of science (even while they are primarily concerned to offer an account of scientific explanation). In the following, I shall refer to their view as the *unificationist thesis* of the unity of science.

According to this view, explaining is unifying. More specifically, according to Friedman, to explain is to show how what appeared to be independent phenomena can be derived from a single principle.⁸ Similarly, according to Kitcher, explaining is minimizing the number of distinct explanatory patterns employed by our theory.⁹ Explanation is construed as deductive derivation: we explain when we deduce some phenomenon from a unifying premise.¹⁰ So, by contrast with the classic conception, the unificationist thesis does not claim that nature is a reductive unity; nor does it guarantee that we will, in the end, be able to unify our theories fully, or to any particular degree. All it says is that nature can be explained *to the extent that* our scientific theories can be unified. But the unificationist thesis is reductionist in this different sense: the quest for scientific explanation, and the understanding achieved through it, is the quest to reduce the number of explanatory principles in our deductive system; it is the quest to explain more from less.

Just as the classic thesis, the unificationist account, too, faces a number of challenges. One problem is that it is saddled with a rather narrow conception of unification and, therefore, a rather narrow conception of explanation and scientific understanding. For example, imagine we want to explain changes in the water quality of the river Cam. The water quality is affected by a large variety of partly dependent, partly independent, factors – the increase of air pollution, for example, or changes in the climate, in agricultural and industrial land-use or in waste water treatment. We have no unified theory that integrates all

⁷ Dupré (1996, 102).

⁸ Friedman (1974, 15).

⁹ Kitcher (1981, 515–19; 1989, 432–33; 1995, 171–73).

¹⁰ The premises most frequently averted to, Friedman and Kitcher argue further, are the most general and fundamental and turn out to be the “statements accepted as laws” (1989, 447; cf. Friedman 1974, 15f.).

these factors. The best way to proceed in explaining the change in water quality will therefore be by drawing on the resources, methods, and insights of *various* relevant scientific fields from chemistry, biology, climate science, and so on. Such ad hoc integration of the results of these different scientific fields can provide us with a good explanation of the water quality of the river Cam without, however, necessarily yielding an overall reduction of the number of independent explanatory principles.¹¹ So, contrary to the unificationist view, it seems that we can sometimes give an explanation, and achieve deeper scientific understanding, at the local level without necessarily achieving a reductive unification in our overarching theory.

In this chapter, I argue that Kant's position is distinct, not only – not surprisingly – from the empiricist view of Oppenheim and Putnam, but also – more surprisingly – from Friedman and Kitcher's unificationist account, which is commonly associated with Kant. Regarding the more obvious contrast with the classic thesis, it is natural to think that the key difference between the classic and the Kantian conceptions consists in the way unity is justified: the proponents of the classic thesis, but not Kant, ground the unity of science empirically. I'll suggest, however, that this does not exhaust the differences. Kant's position differs from the classic reductionist in not only *the way he argues* for the unity of science thesis (not empirically), but also *what he argues* for. In particular, I suggest that the specific notion of the unity of science that follows from his arguments is interestingly non-reductive. This suggestion is brought out further in comparison with the unificationist account. For although, like the unificationist, Kant proposes an epistemological justification for the unity of science, unlike the unificationist, he does not rest his case on a narrow view of the nature of explanation but on an analysis of the conditions under which empirical cognition is possible at all. Since Kant's account of how the possibility of cognition is significantly broader than the unificationist account of explanation, I suggest that the Kantian position leaves room for a distinctive plurality of ways in which cognition, and with it the unity of science, can be achieved.¹²

Before I can say more about these differences, however, I need to say more about Kant's views. In the next sections, I begin by taking a closer look at Kant's conception of unity as spelt out in the *Critique of Pure Reason* and, later, the *Critique of Judgment*. I begin with a first characterization of Kant's conception of unity as an idea of reason (§2.2), before examining the problematic (§2.3) and positive (§2.4) epistemic functions this idea performs.

¹¹ The example is adapted from Mitchell (2003, 194).

¹² I shall say more about the plurality of means by which cognition can be attained on Kant's account in Chapter 3.

This discussion will enable me to develop a more comprehensive account of the epistemic status and content of Kant's idea and to draw out some important implications for its distinctiveness (§2.5). As I conclude (§2.6), this revised conception of Kant's ideal conception of the unity of science will shed interesting light on the contrast with the more recent, unity theses just outlined.

2.2. The systematic unity of cognition – A first characterisation

Kant does not speak explicitly of the 'unity of science'. But he is concerned with the systematic unity of cognition, which he regards as a necessary condition for science. As he puts it in the Doctrine of Method of the *Critique of Pure Reason*, "systematic unity is that which first makes ordinary cognition into science" (A832/B860).¹³ Or, in the terms of the *Metaphysical Foundations of Natural Science*, "every doctrine, if it is supposed to be a system, that is, a whole of cognition ordered according to principles, is called a science" (*MFNS* 4:467, my translation).¹⁴

In order to get a grip on the notion of the unity of science in Kant, we thus need a better understanding of what he means by the systematic unity, or whole, of cognition. To that end, it is important to distinguish the systematic unity of cognitions, which Kant associates with the use of reason (*Vernunftseinheit*), from the unity of cognition brought about by the understanding (*Verstandeseinheit*). Kant calls the former the "collective unity of a whole of experience" and contrasts it with the "distributive unity of the use of the understanding in experience" (A582–83/B610–11). Unfortunately, he does not waste much ink on giving us an explicit account of this contrast. Several clues nevertheless help to shed light on the distinction and, thereby, on the conception of the systematic unity of cognitions.

A first way in which Kant construes the contrast is by distinguishing the unity of reason as a higher-level unity from the more basic unity effected by the understanding. The understanding confers unity on possible experiences by subsuming intuitions under concepts, or "rules," in judgments (A306–07/B363). The understanding thus finds unity in the manifold of sensible intuitions and, through its judgments, brings about determinate empirical cognitions of unified objects. Reason, by contrast, is after a higher order unity, sought, in

¹³ References to the *Critique of Pure Reason* use the standard A/B pagination. For other works, I give an abbreviated title along with the volume and page number of the Academy Edition. Translations are my own, though I have consulted and sometimes followed *The Cambridge Edition of the Works of Immanuel Kant*, edited by Paul Guyer and Allen Wood.

¹⁴ Kant is specifically concerned with the unity of empirical cognitions here. In the following, I shall limit my focus on these.

turn, among concepts and judgments. It seeks unity among the large variety of empirical cognitions, a unity subsumed under higher level concepts and principles. As Kant specifies in the Appendix to the Transcendental Dialectic, “just as the understanding unites the manifold into an object through concepts, so reason on its side unites the manifold of concepts through ideas by positing a certain collective unity as the goal of the understanding’s actions, which are otherwise concerned only with distributive unity” (A644/B672). On this construal of the contrast, the unity of the understanding counts as distributive because it is distributed to any possible *individual* cognition; by contrast, reason aims at a collective unity, searching for what furthermore unites particular collections of cognitions.

One might observe at this point that the activities of the understanding unify not only individual cognitions but also, just like those of reason, any plurality of possible cognitions. This is because the understanding grounds a common character among possible cognitions by determining them in accordance with the a priori concepts of the understanding. As Kant sets out in the Transcendental Analytic, any cognition falls under a set of fundamental a priori concepts and principles of the understanding. They include, for example, the principles that substance persists throughout all change and that all changes of the states of a substance have a cause.¹⁵ Whatever we cognize about the empirical phenomena, for instance, it will be cognition of the states of an enduring substance and of the causal relations between such substances. In this way, the understanding brings about not only the unity of individual cognitions considered on their own; it also effects a unity among the plurality of cognitions by classifying them under such categories as ‘substance’ or ‘cause and effect’.

Does this observation blur the contrast between the unities of reason and understanding? To see that it does not, it is important to recognise that the systematic unity sought by reason, unlike the unity of the understanding, is not grounded in the basic common character that any possible cognition shares with any other, but in the relationship in which such cognitions stand to one another as heterogeneous parts of a single, complete whole. To appreciate this difference, consider again what is achieved by the unity the concepts of the understanding effect in cognition: all empirical cognition has the same basic structure determined by the a priori conditions of the human intellect. All cognition is unified in this fundamental way. But this important insight also has its limitations. For the a priori principles of the understanding do not determine the specific character of things we can cognize such as, for instance, the different kinds of substances (minerals, gases, and so on), the different kinds

¹⁵ A182/B224 and A189/B232.

of causal relations that hold between those substances (physical, chemical, etc.), or the different “particular (empirical) laws” that determine those causal relations (Newton’s laws of planetary motion, Charles’ gas law, and others) (*CJ*, 5:183). All the a priori laws tell us is that, whatever we cognize about the empirical phenomena, it will be cognition of *some* state of an enduring substance, and of *some* causal relations between different substances.

The unity brought about among the plurality of cognitions by means of the understanding is thus a relatively thin, indeterminate unity. It only tells us that for whatever cognition we may have – of whatever specific nature – it shares the common basic character set out by the a priori concepts and principles of the understanding. By contrast, to ask for systematic unity is to enquire whether different cognitions may also be unified in a thicker, more substantial way. For example, can cognitions of different substances and of the different laws that govern those substances be classified into general kinds? Might we, in the end, have one single representation of the totality of what we can cognize, fully accounting for the similarities and differences between individual cognitions and for the relations in which they stand to each other? More generally, do different cognitions have not only a common underlying character but also, collectively and in their particular heterogeneity, make up a complete whole of all there is to cognize?¹⁶

A second way in which Kant defines the systematic unity of cognitions is thus not only as a higher-level unity, but also as a whole, or complete unity. This, I think, is what Kant means when, in the Appendix to the Transcendental Dialectic, he contrasts the systematic unity of cognitions with the aggregative unity of the understanding: the idea of systematic unity “postulates complete unity of the understanding’s cognition, through which this cognition comes to be not merely a contingent aggregate but a system” (A645/B673). While, according to the thinner unity of the understanding, any indeterminate, or ‘contingent’, number of cognitions may be unified by virtue of their shared, homogeneous character, reason seeks a complete unity that accounts for the heterogeneous character of the unity’s parts and assigns them a determinate place within the whole. As Kant puts it further, reason’s search for unity “always presupposes an idea, namely that of the form of the whole of cognition, which ... contains the conditions for determining a priori the place of each part and its relation to the others” (A645/B673). The highest order concept, or idea, which unifies the totality of cognitions should thus be construed as representing the ‘form of the whole of

¹⁶ There is a further question here about the relation between the distributive unity of the understanding and the collective unity of reason. Can the first be realised without the other or is the former dependent on the latter? I shall come back to this question in Chapter 3.

cognitions.’ It is an idea of the complete unity of cognitions that determines the structure in which the parts, i.e., individual cognitions, stand to each other within the whole. The systematic unity of cognitions is, for Kant, both a higher order unity of the plurality of cognitions under principles and a complete unity with a differentiated internal organisation.

In the Appendix, Kant develops this account further by attributing to reason three principles that, he suggests, we need to follow in aiming for the systematic unity of cognitions. The first is concerned with the familiar feature, just outlined, of unity under a higher concept or principle. It is the “principle of the *sameness of kind* in the manifold under higher genera” (A657/B686) and expresses the thought that, wherever there is a manifold of kinds, it can be subsumed under a higher genus. The second is the “principle of the *variety* of what is same in kind under lower species” (A657/B686). It puts forward the other, now familiar, idea that the unity of cognitions is a unity of the complete variety of heterogeneous parts. In other words, for any kind, the unity of cognitions comprises a variety of lower species subordinated under it. With these first two principles of reason, Kant thus further carves out how we aim to achieve the systematic unity of cognitions: by searching for higher-order principles of what is general among particular cognitions and for an account that make sense of the total variety of cognitions that differ in their particularities.¹⁷

In addition, the third principle Kant ascribes to reason adds the further thought that the unity of cognitions rules out “isolated” genera or “jump[s]” in the series of concepts and principles (A659/B687). According to this third principle, between any two cognitions governed by concepts of varying generality, there is another cognition unified by an intermediary concept; there is no limit to the possible intermediary concepts and cognitions. As Kant puts it, the third maxim is a “law of the *affinity* of all concepts, which offers a continuous transition from every species to every other through a graduated increase of varieties” (A657–58/B686–87). While this third maxim adds a new thought to the idea of the systematic unity of cognitions, it is not an entirely separate thought but spells out an additional dimension of the completeness of cognition.¹⁸ While the principle of variety stresses

¹⁷ Guyer (2005, 16) similarly characterizes Kant’s conception of systematic unity, in part, by attributing to it the ideal of the “*pure or idealized* fundamental explanatory concept” (unity under a principle) and “the purely quantitative ideal of indefinite extension” (unity of the complete heterogeneity of parts) – an “explanatory minimum” and a “quantitative maximum.” See also Guyer (2003). Similarly, Willaschek (draft) distinguishes between unity under one principle and completeness as different aspects of Kant’s conception of the systematic unity of cognition.

¹⁸ But compare Guyer (2005) who argues for some important differences between the principle of continuity and the principles of homogeneity and specificity.

the completeness of possible cognitions with respect to their *extent*, the principle of affinity directs our focus to what we might characterise as the completeness of possible cognitions with respect to their *depth*. According to the third principle of reason, the systematic unity of cognition ranges over all, including more and more *fine-grained*, concepts, and thus over all, including more and more *detailed*, cognitions.¹⁹

Kant's discussion in the Introduction and the Appendix to the *Transcendental Dialectic* gives us a first characterisation of the concept of systematic unity as presented in the *Critique of Pure Reason*: the systematic unity of cognitions is bound by a highest most general concept, or idea, at the top, with a multiplicity of more specific concepts ordered underneath, and fully complete in its depth and extension. In order to understand how this idea informs Kant's account of the unity of science, however, we need not only a firm grip on the content of the concept of a systematic whole of cognitions, but also a better understanding of the role this concept plays in scientific enquiry. This role is complex; it has a negative, or problematic, and a positive part. On the one hand, Kant holds, we in principle cannot know whether all possible cognitions form a systematic unity. Indeed, Kant thinks that if it is misapplied, the idea of such a unity leads to fundamental metaphysical errors. On the other hand, Kant further argues that the concept of a systematic unity is nevertheless necessary for cognition and, in particular, for scientific cognition. My focus in this chapter is not on the first, problematic, but on the second, positive, role of the concept of systematic unity. Since the latter cannot be treated in entire isolation from the former, however, I start by saying a few words about the difficulties that arise from any attempt to attain the systematic unity of cognitions. This is what I turn to in the next section.

2.3. The problematic epistemic status of the idea of systematic unity

The concept of the systematic unity of cognitions, for Kant, is an a priori idea of reason. It is not grounded in the empirical evidence but in the nature of human reason. Reason, as Kant tells his readers, is the “faculty of principles” and “of drawing inferences mediately” (A299/B355–56). It is the faculty to spell out the consequences of higher-order principles, on the one hand, and to infer to the higher-order principles that subsume a given manifold of cognitions on the other. Relatedly, reason can also be characterised as concerned with “the relation between a cognition and its condition”, where this condition can be represented as

¹⁹ Cf. Grier on complete definitions and clear exposition of all characteristics of an object as part of the idea of systematic unity (2001, 283–84).

the principle, or “major premise”, in an inference (A304/B361).²⁰ To use one’s reason, to draw inferences from or to higher order principles, is to inquire into the conditions of things. It is to demand explanations and to pursue further, more extensive or deeper, cognition. And it is to do so relentlessly and consistently: it is to search for *ultimate* conditions and demand *complete* explanations and, in sum, to seek *fully unified* cognition. The activities of reason, Kant thus suggests, presuppose the idea of a complete unity of cognitions. As he puts it, the idea is grounded in the very character of reason: “reason is by nature architectonic, i.e., it considers all cognitions as belonging to a possible system” (A474/B502).

Kant also thinks, however, that reason’s demand to pursue systematic unity is deeply problematic. He famously argues that it is the source of substantial errors that has led many of his own contemporaries into a fundamentally misguided kind of metaphysical speculation. So, what is the difficulty?

The difficulty arises, Kant argues, because reason in its search for systematicity moves from a logical to a metaphysical principle of reason. In its search for the unifying conditions of things, reason first of all follows the logical maxim “to find the unconditioned for conditioned cognitions” (A307/B364). This maxim is logical because it is concerned with the activities of reason itself and with the methodology reason follows in its activities. But the maxim makes no claim about the content of the cognitions thus attained or the nature of the objects thus cognised. The difficulty arises when, in reasoning according to this maxim, we make the further assumption that, “when the conditioned is given, then so is the whole series of conditions subordinated one to the other, which is itself unconditioned, also given (i.e., contained in the object and its connection)” (A307–08/B364). This second principle is not purely logical one. It makes a claim not only about the subjective method governing the activities of reason but also about the objective conditions that determine the cognitions to be attained through these activities. More specifically, it makes a claim about the givenness of ultimate objective conditions that ground the complete unity of possible cognitions.²¹ The progression from a subjective and logical to an objective and metaphysical principle thus lands us in the domain of metaphysical speculation that Kant warns against.

²⁰ See Watkins (forthcoming) on conditions.

²¹ As Michelle Grier (2001, 122) characterises the move, it consists in “a slide from a principle representing a subjective necessity” – the necessity of reason to search for the unconditioned – to a “principle asserting an objective necessity” – the necessity of the unconditioned being given whenever the conditioned object of cognition is given.

But what is so problematic about the metaphysical assumption of an unconditioned condition? The reason why such an assumption leads to error, according to Kant, has to do with the nature of cognition. As Kant had already shown in the *Transcendental Analytic*, cognition is limited by the bounds of sense: all (empirical) cognition is conditioned by intuitions given in sensibility and by the concepts and principles of the understanding. Cognition of something entirely unconditioned is in principle impossible. This is why Kant argues that the notion of an unconditioned condition and, with it, of a systematic unity of cognitions is not “the concept of an object” (A645/B673) but “a mere idea” (A647/B675). It is not a concept that can subsume any object given in sensibility but an idea without determinate application to the phenomena. To think otherwise, and to assert claims about the unconditioned condition of any particular domain of cognitions, is to fall prey to illusion. Kant’s dialectical arguments are meant to show this for the traditional domains of metaphysics. Reason’s search for the unconditioned in the domains of psychology, cosmology, and theology leads into contradictions about the self, world, and God. In its attempt to gain cognition of the ultimate conditions of, and have fully unified cognitions about, the self, world, and God, reason hankers after what lies beyond our ken.

We might think, of course, that the illusions could be avoided, and the error side-stepped, if the move from the logical to the metaphysical principle of unity were a simple and harmless oversight. Once detected, the error could be avoided. But in Kant’s books the move is more than an oversight. Kant makes two important but initially puzzling claims to this effect. First, he argues that the slide from the logical to the metaphysical principle is necessary for the kind of reasoners we are. As he puts it in the *Introduction to the Transcendental Dialectic*, the logical principle of systematic unity only becomes a true “principle of pure reason” insofar as it is grounded in a metaphysical principle (A307/B364). In our reasoning activities, we naturally follow not only the purely logical, or methodological, maxim to search for ultimate explanations, and unconditioned conditions, but also assume that nature is indeed conditioned, and can be explained, in this way. Similarly, in the *Appendix* Kant adds that, if the logical principle is to be employed in the search for unified cognition, we must presuppose that the objects are such that they can be cognized by this method; otherwise reason would “set as its goal an idea [namely that of the unity of cognitions] that entirely contradicts the arrangement of nature [namely its disunity]” (A651/B679). For us the move from the logical to the metaphysical principle is therefore, Kant holds, “indispensably necessary” (A644/B672). But this is surprising. Is Kant saying we are fated to fall into

illusion? Or is there a way to make this move from the logical to a metaphysical principle of unity that does not fall into illusion?

Second, Kant further argues that the metaphysical principle, if properly understood, is not only necessary for the kinds of reasoners we are; it is also one that informs the possibility of cognition. In particular, Kant claims that the move from a logical to a metaphysical principle has a heuristic use for the kind of systematic cognition we seek in science. The illusion of an ultimate condition functions as an important guide in extending cognition beyond what is immediately accessible to our senses; it is needed “if besides the objects before our eyes we want to see those that lie far in the background” (A644–45/B672–73). In fact, Kant now argues that the logical principle has at the same time a “transcendental” character (A650–51/B678–79). And, to avoid any ambiguity on this last point, he makes similar claims about the three more specific principles of reason that he associates with the idea of systematic unity – the principles of homogeneity, specificity and affinity. All of these, he argues, rely on a transcendental version of the same maxims: if our search for systematic cognition of higher order genera, lower order species or intermediary kinds is to have any success, we must assume that nature is such that it can be cognised in the way in which we try to cognise it. That is, we have to presuppose that nature is such that it can be ordered according to genera and species, and that its kinds stand in relations of continuity to one another.²² Similarly, as Kant elaborates further in the Introduction to the *Critique of Judgment*, the idea of the unity of nature presupposed in such well-known maxims as “nature takes the shortest way” (*lex parsimoniae*); ‘it makes no leaps ...’ (*lex continui in natura*); ‘the great multiplicity of its empirical laws is nevertheless unity under a few principles’ (*principia praeter necessitatem non sunt multiplicanda*); and so on” (CJ, 5:182) has transcendental status, since it pertains to the possibility of our cognition of nature.

This second Kantian claim, too, is important as it is initially puzzling. Kant asserts that the metaphysical principle leads us to error and illusion, but also that we *must* adopt it and that it is in fact *useful for cognition*. How can he hold these claims simultaneously? Kant famously argues he can do so because he assigns the metaphysical principle, and with it the idea of systematic unity, a special status: they are “regulative,” not “constitutive” (A644/B672). That is, they do not make any determinate claims about the nature of things but serve as a heuristic guide enquiry. They are no tools for making truth claims about the sought-after systematic unity of cognitions, but guide the “hypothetical use of reason” in the

²² See A654–60/B682–88.

attempt to bring unity into our cognitions (A647/B675). As Kant thus claims, the yearning after the unknowable is not, in principle, reprehensible – as long as it is construed in the right way. It is harmless, and indeed fruitful, if it is understood as a regulative guide to cognition.²³

But Kant’s argumentative move from the problematic to the positive role of the idea of systematic unity raises a number of controversial questions. Why should we believe that an idea that has been shown to be so dubious can indeed be put to such beneficial use? Why not simply regard Kant’s regulative interpretation of the idea of systematic unity as a way of making the move from a logical to a metaphysical principle epistemically harmless? Why go further and ascribe to this move an inevitably necessary, even transcendental, regulative function for cognition? More thus needs to be said about the reasons that ground Kant’s important yet controversial claims about the positive role of the idea of the systematic unity of cognition. This is what I come to now.

2.4. The positive regulative role of the idea of systematic unity

Why, then, does the search for systematic cognition demand the move to a regulative, transcendental principle of systematic unity on Kant’s account? Why not think with Paul Guyer that the regulative principle of systematic unity is a way of transforming a subjective need into “a self-serving delusion” rather than a useful heuristic?²⁴ According to the challenge raised by Guyer, and discussed in some detail by Hannah Ginsborg, Kant’s argument relies on the claim that it would be irrational to engage in an activity without the promise of success.²⁵ On Guyer’s reading of Kant, one must believe that the search for systematic unity

²³ The illusion of a given unconditioned that arises from the move to the metaphysical principle can thus act as a productive stimulus for human enquiry if it is understood as a regulative idea. The real error and contradiction result only if we mistake the metaphysical principle for a constitutive one. This is brought out very clearly by Willaschek (draft). See also Grier (2001, 127–28) and Buchdahl (1969, 527).

²⁴ Guyer (1997, 42).

²⁵ Guyer (1997, 35–47); Ginsborg (2017). The differences between interpretations such as Guyer’s and Ginsborg’s open up a complex exegetical controversy that I cannot go into in full here. In addition to the concern whether Kant offers any convincing arguments for the necessity of not only the logical but also the transcendental status of the principle of systematic unity, which I discuss in this section, a couple further issues can be distinguished. The first is the related question of how Kant’s arguments in *CPR* and *CJ*, and his accounts of reason and judgment, stand to each other. Guyer (2005, chapters 1 and 3) argues for an important shift, while Ginsborg 2017 observes a continuity. See also Longuenesse (1998) who finds many of the claims attributed to Kant’s theory of judgment in *CJ* already contained in the *Analytic of CPR*. Second, one may wonder what, according to Kant, the principles of systematic unity are necessary for – scientific cognition in particular or any type of cognition in general. Again, Guyer and Ginsborg’s readings lie at opposite ends of the interpretative spectrum; while Guyer takes

will be successful, and “that nature itself is systematic” in order for our search for systematic cognition to be rationally motivated. But this picture of rationality is overly strong, Guyer objects. All we need in order for our search to be rational, he argues, is to believe that it is not outright impossible.

Against Guyer, I would like to make two points. First, Kant’s argument for the move from a logical to a metaphysical principle of unity does not hinge on a presupposition of the success but rather of the possibility of systematic cognition. And, second, this assumption of possibility is not primarily a matter of practical rationality, as Guyer implies, but is deeply seated in considerations about theoretical rationality. More specifically, it is an assumption of the possibility of systematic cognition that is necessary for extending cognition beyond the most rudimentary empirical kind. In particular, I suggest that the assumption of a totality of all cognitions, and of a natural world that is such that it can be known in its totality, is necessary for cognition of such things as kinds of substances, causal laws, and the interactions between substances. For, in order to regard more empirical evidence as getting us closer to the truth, we must assume that there is a complete unity of things to be cognized, and a complete unity of possible cognitions. We must assume that finding out *more* gets us closer to knowing *all*.

To put this into the Kantian context, remember first that there are certain insights the understanding provides us a priori about the more remote objects of cognition. For example, we know a priori that every change in the states of a substance has a cause and stands under some particular causal law. By contrast, we do not know a priori which cause brings about which effect or which empirical regularity is a genuine law. For such further insight, empirical enquiry is needed. The a priori principle of causality, spelt out in the Second Analogy, for example, does not specify the cause of the increasing temperature of a stone in the sun. But it states that there must be *something* that caused the temperature to change; and there must be some particular causal law in accordance with which the change occurred. The principle of the Second Analogy thus guides the search for particular laws by directing us to reflect on appearances in accordance with the a priori concepts of cause and effect; it instructs us to search for something *A* that stands to some other given thing *B* just as a cause stands to its effect. The a priori principle thereby gives us reason to identify the relation expressed by the concepts of pure understanding with that of actual or possible appearances in time. As Kant

the former position, Ginsborg argues for the latter. I say more about these two further issues, respectively, in Chapters 3 and 4 below.

puts it in the Analogies of Experience section, “we will be justified in combining appearances ... according to an analogy with the logical and universal unity of concepts” (A181/B224).²⁶

In this search, to ascertain whether we have identified a thing as the cause of some given appearance, our only hope is to compare the given particular with other similar cases. We need to ask whether same kinds of cause have same kinds of effect, and whether we have thus identified a generalization with universal validity for phenomena of a particular kind. We will have to rely on a process of reflection on and comparison with other empirical phenomena. On its own, however, this kind of empirical enquiry prompts all sorts of well-known sceptical worries: why does comparing one instance of a stone being warmed by the sun with another, similar, instance give us any more evidence of a causal relation between the increase in temperature and the radiation of the sun? Both instances might equally point to entirely different underlying relations. More generally, why should we expect to be able to identify kinds of things or relations at all? It might be possible that no kinds or classes could ever be made out. In Kant’s words, it is conceivable that “among the appearance offering themselves to us there were such a great variety ... that even the most acute human understanding, through comparison of one with another, could not detect the least similarity” (A653/B681). If, however, we had access to all the relevant instances and all the relevant conditions of those instances, and if those instances themselves formed a systematic unity, knowing a bit more about the empirical evidence would get us closer to our goal.

Kant’s point, then, is that in our search for particular causal laws we must assume as a regulative guide that it is at least in principle possible to enquire into the relevant instances and, hence, that the natural world is such that it presents a whole that can be known in its complete and systematic totality. In order to regard empirical data as evidence for or against a particular empirical cognition, we must follow the regulative principle that the empirical data we have gathered contributes to completing all there is to be found out about the phenomena. And this, in turn, relies on the idea, not only of a unified totality of all cognitions, but also of a complete totality of what there is to be cognized, a unity of nature. On this suggestion, only if we assume ideal unity in this sense, can we thus take particular empirical enquiry as getting us closer to knowing what there is to be known about the phenomena.

²⁶ I am skirting over important details here. For more on the dual regulative and constitutive role of the Analogies of Experience, see Chapter 3.

According to the proposed reading, the metaphysical principle is necessarily implied in our search for systematic cognition. In this sense, pace Guyer, it is primarily a principle of theoretical reason.²⁷ Moreover, it is a principle that does not assume the success of our search for systematic cognition, e.g. our search for particular causal laws or the interaction between specific substances. Even if we take it as a regulative principle that there exists a fully unified and systematically ordered natural world that is in principle cognitively accessible to us, all we would thereby have secured was the possibility of knowing. Human limitations could – and do – still get in the way of success. What we would presuppose is the possibility that our attempts at understanding more were not doomed from the start.

This regulative metaphysical conception of the systematic unity of nature spells out an idea of nature as fitting our epistemic needs. It is a regulative ideal of the natural world that is fully accessible to human understanding. Kant goes on to present this ideal in teleological terms, as the conception of nature as a purposive unity. He first elaborates on this thought in the Appendix in the context of the more specific ideas of reason, of the self, world, and God, as particular instances of this idea in the three domains of psychology, cosmology, and theology.²⁸ The third and most comprehensive idea, meant to guide enquiry in theology, is one that presents the world as intentional object of a highest intelligence, or reason. The “highest” unity, Kant says, “is the *purposive* unity of things; and the *speculative* interest of reason makes it necessary to regard every ordinance in the world as if it had sprouted from the intention of a highest reason” (A686/B714; see also A694–95/B723–24). The idea presented here is that nature is unified in the sense that it is conceived by a mind. It is the intentional object of a mind and, thus, an object fully accessible to, because brought about by, a highest reason. Not only that, Kant relates this rational unity to the possibility of the use of human reason: “The greatest systematic unity, consequently also purposive unity, is the school and even the ground of the possibility of the greatest use of human reason” (A694–95/B722–23). In other words, construing nature as the intentional object of a highest reason is to think of nature as brought about in such a way that it is fully cognitively accessible to us, too. It is to think of nature as brought about by a highest reason for our reason.

²⁷ I come back to the question of the practical dimension of the principle of systematic unity in Chapter 6.

²⁸ Grier (2001, 267–68) stresses the importance of distinguishing between the specific ideas of reason and the general principle of the systematic unity. The ideas of reason, as I understand them, give us the indeterminate object that, in our enquiries, we aim to cognise.

In the Introduction to the *Critique of Judgment*, Kant further elaborates on this teleological idea of the systematic unity of nature. The principle of the unity of nature “can be nothing other than this: that... the particular empirical laws... must be considered in terms of the sort of unity they would have if an understanding (even if not ours) had likewise given them for the sake of our faculty of cognition, in order to make possible a system of experience in accordance with particular laws of nature” (*CJ*, 5:180). Again, Kant suggests that the principle of systematic unity presents nature as unified not only by a mind, but also for a mind – namely, ours. According to this principle, we construe nature such that it can completely be understood by the human intellect. We take it as a regulative principle that nature is there to be fully cognitively available to us.

The systematic unity of nature is thus defined by reference to our understanding. Nature would be fully systematically unified if it were fully accessible to our understanding. And cognition would be fully systematically unified if it made the natural world fully understandable to us as a whole. In Ginsborg’s response to Guyer, she similarly points out that, even though the regulative, transcendental principle is about nature, it is not a factual but a normative principle, since it makes irreducible reference to our judging activity.²⁹ Although I do not find it useful to rely on normative terminology here, I think Ginsborg is right in stressing the relational dimension of the principle: it concerns the fit between our intellect and the natural world, or about nature being suitable to our understanding.³⁰

I would like to suggest, then, that on Kant’s account the transcendental principle of systematic unity is not a ‘self-serving delusion’ but a regulative principle necessary in the search for systematic cognition. Without it, not even the possibility of successful empirical enquiry would be secured.

2.5. The systematic unity of cognitions reconsidered

I began my discussion of Kant’s conception of the systematic, or collective, unity of cognitions with an initial characterisation. According to this characterisation, the systematic unity of cognitions is a complete unity, bound by a highest most unifying concept at the top, with a multiplicity of more specific concepts ordered underneath. In the subsequent discussion, I

²⁹ Ginsborg (2017, 77).

³⁰ I come to my disagreements with Ginsborg’s reading in Chapter 3. For now, it is sufficient to stress that I take this fit to be required for cognition, not because cognition as such is a primitive normative relation, but because anything that goes beyond the most rudimentary cognitions always relies on a form of systematisation which, in turn, requires the assumption of fit between understanding and world. Cf. also Geiger (2003).

then looked at the dual problematic-positive role of this idea and the logical and metaphysical principles Kant associates with it. Employed in the context of a purely logical principle, the idea drives our search for more and more systematic cognition. But it also naturally moves us to adopt a metaphysical principle that, if mistaken for a constitutive principle, leads to the idea of the unity of nature as given and thence to metaphysical error. Understood as a purely regulative principle, by contrast, the metaphysical principle guides our search for systematic cognition by presupposing a regulative idea of the unity of nature as suitable to our epistemic needs. In this section, I suggest that the foregoing considerations about the complex role of the idea of the systematic unity of cognitions shed further light on the initial characterisation of this idea. In particular, I argue that Kant's account of its legitimate regulative function, and of the idea of the systematic unity of nature, offers additional insight into what the systematic unity of cognitions might amount to.

Before spelling out these implications for a more comprehensive characterisation of Kant's conception, let me first say a few words about an alternative reading that, I think, is at least incomplete. This alternative reading stresses the hierarchical nature of Kant's initial notion of the systematic unity of cognitions: the unity is structured by a highest concept which subsumes more and more specific concepts hierarchically ordered underneath. On this reading, when we think of the corresponding idea of the systematic unity of nature, purposively arranged for our understanding, we think of nature as suitable for conceptualisation according to a hierarchy of concepts. According to this proposal, the idea of the systematic unity of nature thus presents the natural world as purposive for our understanding insofar as it makes possible the complete unity of all cognitions of nature – a unity that is ultimately bound by a highest, most general concept hierarchically subordinating all other more specific concepts.³¹

Although I think this picture is suggested by the order of Kant's presentation in the *Transcendental Dialectic*, it cannot be the full story. We should therefore not simply read the structure of Kant's initial characterisation of the systematic unity of cognitions into the idea of the systematic unity of nature that emerges in the Appendix and the Introduction to the *Critique of Judgment*; but should rather take any insight gained from the subsequent discussion in the Appendix and the third *Critique* as grounds for reassessing our initial characterisation of

³¹ Willaschek (draft, in particular Chapter 2), too, problematizes the relation between the hierarchical conception of unity, ordered in terms of the generality of concepts, and the notion of unity as ordered by a highest idea (draft, 79–80). He nevertheless foregrounds the hierarchical notion without saying much about the teleological notion of unity.

the systematic unity of cognitions. As this reassessment will make clear, the idea of the systematic unity of cognitions that emerges from Kant's more comprehensive account is not the simple hierarchical conception but one of a unity of cognitions that is fundamentally bound by an idea of complete comprehensibility. Let me make two points to support and clarify this suggestion.

The first is that, although Kant sometimes presents the unity of science as a hierarchy of concepts and principles, the highest cannot be one of a kind with the concepts and principles ordered underneath. For, as the discussion of the problematic status of the idea of unity has shown, the highest concept is one is not one we can grasp. This means that it is not one of the most fundamental laws of nature such as, for example, the metaphysical laws of natural science.³² It should rather be viewed, as Kant had put it in the Appendix, as "an idea, namely that of the form of the whole" (A645/B673) – an idea from which, more generally, the relation between the variety of the parts of the whole could be grasped if it were available to us. Kant's discussion of the regulative idea of the systematic unity of nature can now shed further light on this thought. The latter notion of the systematic unity of nature illustrates how the sought-after idea of the whole might be thought: as an idea of the whole of nature in which every part is ordered purposively for our understanding of it.

In the Appendix, Kant elaborates on this conception in his famous metaphor of a standpoint:

One can regard every concept as a point, which, as the standpoint of an observer, has its horizon, i.e., a multiplicity of things that can be represented and surveyed, as it were, from it. Within this horizon a multiplicity of points must be able to be given to infinity, each of which in turn has its narrower field of view; i.e., every species contains subspecies in accordance with the principle of specification, and the logical horizon consists only of smaller horizons (subspecies), but not of points that have no domain (individuals). ... finally the highest genus is the universal and true horizon, determined from the standpoint of the highest concept and comprehending all manifoldness, as genera, species, and subspecies, under itself (A658–59/B686–87).

³² I take this to speak against Friedman's reading of the metaphysical laws as anchoring the systematic unity of nature.

The highest point of view, if it could be entertained, would be one from which we could survey the totality of all lower, or more specific, limited points. It would be one which combines all horizons in one overall point of view. The unifying idea of the whole thus relies on a standpoint which makes nature understandable to us *as a whole*. One important implication of this is that this idea of the unity of cognitions as bound by the most encompassing point of view makes no claims about the homogeneity of the concepts or species involved, nor about the deductive nature of the relation between those concepts. It is rather construed as a unity bound by an idea that assigns the great variety of parts their determinate place within the whole for the purpose of our understanding of it.

The second important point to note is that, by contrast with what is implied by a hierarchical conception of unity, on Kant's account unified understanding is gained not only by derivation from a higher principle but can take all kinds of different forms. Again, this point is brought out by Kant's account of the systematic unity of nature. Nature is unified, on this account, in relation to our understanding. It has systematic unity insofar as it is fully understandable to us as a whole. But, for Kant, not all understanding is the result of derivation from a higher principle. Although Kant sometimes uses 'explanation' [*Erklärung*] narrowly as "derivation from a principle,"³³ he also introduces a wide variety of other empirical and intellectual activities that contribute to understanding. For example, understanding can be the result of inductive or analogical inference³⁴, of teleological reflection,³⁵ systematic classification, which Kant calls "description of nature" [*Naturbeschreibung*],³⁶ or systematic analysis, which Kant calls "exposition" [*Exposition*].³⁷ Even though not all these activities consist in derivation from a principle, they are activities that lead to the formulation of cognitive claims. Some may do so directly, others indirectly – but all are part of scientific activity in the full sense.

What this shows is that, for Kant, to pursue the unity of cognitions is not simply to look for the highest principle from which all else can be reduced, but to search for understanding of how different objects and processes hang together. The kind of systematic

³³ For example, in the *Critique of Judgment* Kant declares "erklären heißt, von einem Prinzip ableiten" (*CJ* 5:412).

³⁴ See, e.g., *JL*, 9:132–33.

³⁵ See Kant's discussion of our attempts to comprehend organic phenomena in the second part of the *Critique of Judgment*.

³⁶ See *CJ* 5:417; *MFNS* 4:47.

³⁷ *JL* 9:142–43; *CJ* 5:412.

unity required for full understanding is one that makes the systematic relation of each part to every other part comprehensible to us within the whole.

Kant's initial presentation of the systematic unity of cognitions, as bound by a highest most general concept, or idea, at the top, with a multiplicity of more specific concepts ordered underneath, and fully complete in its depth and extension, thus needs to be supplemented by the results of his subsequent discussion. This further discussion shows that the idea of the systematic unity of cognitions entails the idea of complete comprehensibility, and thereby the further idea of nature as being such that it is completely understandable to us. And, on Kant's account, this more comprehensive idea of the systematic unity of cognitions drives not only a specific kind of scientific explanation – derivation from a general principle – but any attempt at gaining empirical cognition more broadly.

2.6. Conclusion: The distinctness of Kant's account of ideal unity

Coming back, finally, to my original question about the distinctness of Kant's account, it is important to remember that, for Kant, the systematic unity of cognitions is the hallmark of a science. Science would be fully unified, according to Kant, if – *per impossibile* – we had achieved the systematic unity of cognitions. How then does Kant's conception of the unity of science compare to the more recent and more well-known unity theses?

First, one might think that Kant and more recent proponents of the classic unity of science thesis are agreed on the content of the idea of the unity of science – hierarchical and reductionist – yet hold different views about the status of that idea – as a well-established empirical hypothesis on the classic account and as a necessary regulative idea of reason on Kant's account. But we can now see why Kant's position is distinct from the classic thesis in more than one way. Kant proposes a unity whose parts are not defined in reductionist terms. Kant's rejection of the empirical approach thus implies a further difference in the kind of unity he argues for – it is a kind of unity that leaves room for non-hierarchical and non-reductionist accounts of natural phenomena.

Second, Kant's position is distinct from the well-known Kantian unificationist thesis. Consider, for example, Kitcher's assimilation of Kant with the unificationist thesis – in particular, the view that unification is required for explanation, where to explain is to reduce the number of explanatory principles in our deductive system. Although Kitcher is right that, for Kant, the idea of unity is central to science, and in particular central to the knowledge of empirical laws, Kitcher is wrong in identifying unification too narrowly with scientific

explanation – construed as deduction from general principles. For Kant, understanding can be reached in a variety of different ways. The unity of cognition required to achieve such understanding is thus not the unity that resolves in a highest overall principle from which all else can be deduced. It is a unity that gives us full understanding of the relations between its parts, relations that may be other than reductive.

I believe that this result has further implications for those recent critics of the unity of science thesis who regard that thesis as inherently incompatible with the need for non-reductionist and pluralist approaches in science. But more on this elsewhere.³⁸

³⁸ Chapter 5 will spell out this proposal in detail.

Bibliography

- Allison, Henry 2004. *Kant's Transcendental Idealism: An Interpretation and Defence*, Newhaven: Yale University Press.
- Breitenbach, Angela 2017. "Laws in Biology and the Unity of Nature," in Massimi and Breitenbach, eds., *Kant and the Laws of Nature*, 237–55.
- . forthcoming. "Laws and Ideal Unity," in Walter Ott and Lydia Patton forthcoming. *Laws of Nature*, Oxford: Oxford University Press.
- Breitenbach, Angela and Yoon Choi 2017. "Pluralism and the Unity of Science," *The Monist* 100: 391–405.
- Brigandt, Ingo 2010. "Beyond Reduction and Pluralism: Toward an Epistemology of Explanatory Integration in Biology," *Erkenntnis* 73: 295–311.
- Buchdahl, Gerd 1969. *Metaphysics and the Philosophy of Science*, Oxford: Blackwell.
- Carnap, Rudolf 1928. *The Logical Construction of the World; Pseudoproblems in Philosophy*, Berkeley: University of California Press.
- Carnap, R., H. Hahn and O. Neurath, 1929/1973, 'The Scientific Conception of the World: The Vienna Circle', in Neurath 1973, *Empiricism and Sociology*, R. S. Cohen and M. Neurath, eds., Dordrecht: Reidel. 299–318.
- Cartwright, Nancy 1999. *The Dappled World: A Study of the Boundaries of Science*, Cambridge: Cambridge University Press.
- Chang, Hasok 2012. *Is Water H₂O? Evidence, Pluralism and Realism*, Dordrecht: Springer.
- Dupré, John 1993. *The Disorder of Things: Metaphysical Foundations of the Disunity of Science*, Cambridge, MA: Harvard University Press.
- . 1996. "Metaphysical Disorder and Scientific Disunity," in Peter Galison and David J. Stump, eds., *The Disunity of Science: Boundaries, Context and Power*, Stanford: Stanford University Press, 101–17.
- Friedman, Michael 1974. "Explanation and Scientific Understanding," *Journal of Philosophy* 71: 5–19.
- . 2001. *The Dynamics of Reason*. Stanford: CSLI Publications.
- Geiger, Ido 2003. 'Is the Assumption of a Systematic Whole of Empirical Concepts A Necessary Condition of Knowledge?', *Kant-Studien* 94: 273–98.
- Ginsborg, Hannah 2015. *The Normativity of Nature*, Oxford: Oxford University Press.
- . 2017. 'Why Must we Presuppose the Systematicity of Nature?' in Michela Massimi and Angela Breitenbach, eds., *Kant and the Laws of Nature*, 71–88.

- Grier, Michelle 2001. *Kant's Doctrine of Transcendental Illusion*, Cambridge: Cambridge University Press.
- Guyer, Paul 1997. *Kant and the Claims of Taste*, Cambridge: Cambridge University Press.
- . 2003. 'Kant's Principles of Reflecting Judgment,' in Guyer (eds.), *Kant's Critique of the Power of Judgment: Critical Essays*, Oxford: Rowman and Littlefield, 1–62.
- . 2005. *Kant's System of Nature and Freedom: Selected Essays*, Oxford: Oxford University Press
- Kant, Immanuel 1900ff. *Kants Werke*, Berlin: Preußische Akademie der Wissenschaften.
- .
- Kitcher, Philip 1981. "Explanatory Unification," *Philosophy of Science* 48: 507–531.
- . 1989. "Explanatory Unification and the Causal Structure of the World," in Kitcher and Salmon, eds. *Scientific Explanation*, Minneapolis: University of Minnesota Press. (1989: 410–505).
- . 1995. *The Advancement of Science: Science without Legend, Objectivity Without Illusions*, Oxford: Oxford University Press.
- Longuenesse, Béatrice 1998. *Kant and the Capacity to Judge: Sensibility and Discursivity in the Transcendental Analytic of the Critique of Pure Reason*, Princeton: Princeton University Press.
- Mitchell, Sandra 2003. *Biological Complexity and Integrative Pluralism*, Cambridge: Cambridge University Press.
- Neurath, Otto 1937/1983, 'Unity of Science and its Encyclopedia', in Neurath 1983, *Philosophical Papers 1913-1946*, R.S. Cohen and M. Neurath, eds., Dordrecht: Reidel. 172–82.
- Oppenheim, Paul and Putnam, Hilary 1958. "The Unity of Science as a Working Hypothesis," *Minnesota Studies in the Philosophy of Science* 2: 3–36.
- Putnam, Hilary 1975. *Mind, Language and Reality: Philosophical Papers*, Vol. 2, Cambridge: Cambridge University Press.
- Watkins, Eric forthcoming. 'Kant on Real Conditions', in V. L. Waibel and M. Ruffing (eds.), *Kant-Kongressakten*, Berlin: de Gruyter.
- Willaschek, Marcus draft. *Necessary Questions: Kant on Reason and Metaphysics*.
- Zuckert, Rachel 2017. 'Empirical Scientific Investigation and the Ideas of Reason', in Massimi and Breitenbach, eds., *Kant and the Laws of Nature*, 89–107.