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‘The Shape of a Four-footed Animal in General:’

Kant on Empirical Schemata and the System of Nature

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**ABSTRACT** In this paper, I argue that although Kant’s account of empirical schemata in the *Critique of Pure Reason* is primarily used to explain the shared content of intuitions and empirical concepts, it is also informed by methodological problems in natural history. I argue that empirical schemata, which are rules for determining the spatio-temporal form of objects, not only serve to connect individual intuitions with concepts, but also concern the very features of objects on the basis of which they were connected and ordered in taxonomic systems based on similarity of form. I then suggest that Kant likely had scientific illustrations in mind in his discussion of empirical images in the Schematism chapter and that his account of schemata can help explain the epistemic function of these images in early modern science.

 For Immanuel Kant, concepts only have “sense and significance” if they relate to objects; otherwise, they are “empty” thought-entities (Kant 1781-87/ 1998, A51/ B75; A240/ B299). There is, however, a notorious problem with respect to the relation of concepts to objects. Concepts are essentially general representations, while objects are always particular, with a richness and determinacy that far outstrips conceptual representation. As Kant puts it in the Schematism chapter of the *Critique of Pure Reason*, “No image of a triangle would ever be adequate to the concept of it. For it would not attain the generality of the concept, which makes this valid for all triangles, right or acute, etc. ” (1781-87/ 1998, A141/ B180). The concept of a triangle is what Kant calls a “pure sensible concept,” i.e., a concept that arises from an a priori determination of space rather than from empirical observation. The image of a triangle that results from this a priori determination is far less rich in detail than any empirical object, but is still inadequate to the concept. “Even less,” he adds, “does an object of experience or an image of it ever reach the empirical concept” (1781-87/ 1998, A141/ B180). Kant appeals to schemata to bridge the gap between intuitions and concepts. He defines a schema as a “representation of a general procedure of the imagination for providing a concept with its image” and a “rule for the determination of intuition in accordance with a certain general concept” (1781/87/1998, A141/ B180).

 Most commentators have taken Kant’s account of empirical schemata to concern a problem—or perhaps better, a set of problems—that would now be the subject matter of perceptual psychology. That is, they have taken Kant to be concerned with the question of how one can apply general concepts to perceptually given particulars. Or how one can overcome the inherently perspectival nature of perceptual experience in order to form stable images of objects in accordance with concepts. Or how one can even form general concepts on the basis of the perception of particulars.[[1]](#endnote-1) These commentators have correspondingly taken empirical schemata to be perceptual rules for the apprehension of objects that—depending on how they view the fundamental problem—either underwrite empirical concept formation or empirical concept application.

 In what follows, I argue that Kant has a different set of problems in mind and that this has important consequences for how we should understand the function of empirical schemata. To begin, the philosophical problem with which Kant is concerned in the Schematism chapter is more fundamental than the problems of either concept formation or application. Even in the empirical case, Kant is concerned with the question of *how it is even possible* for concepts, which are essentially general representations, and intuitions, which are essentially singular, to have shared content. Kant recognizes that the sense and significance of concepts rests on sensible content, yet we cannot understand this content in terms of any particular sensible object or image, because this will not support the logical structure of concepts. For Kant, it is only by appealing to the spatio-temporal form of sensible objects that we can account for the sensible generality that connects intuitions to concepts. Importantly, this means that empirical schemata are perceptual rules for the delineation of the spatio-temporal, and especially the *spatial*,form of objects, a point that is often obscured in interpretations of empirical schemata.[[2]](#endnote-2)

 But as I will argue, a methodological problem in natural history also informs Kant’s discussion of empirical schemata. Naturalists at the time were in search of classificatory principles that would bring order to the overwhelming diversity of natural forms they confronted. They were, in other words, attempting to construct a system of nature, and they were doing so largely on the basis of the *similarity of form* of natural objects. Kant would have recognized that this latter point bears out his own account of how concepts and intuitions can have shared content. The schemata of empirical concepts—as rules for the delineation of the spatio-temporal form of objects—direct us to those features of objects in virtue of which they can be subsumed under concepts in a system of nature. In some cases—e.g., Linnaeus’ method of determining the shape and number of pistils and stamens in order to classify plants—we can think of empirical schemata as providing the methods or procedures for attending to the form of natural objects in order to recognize them under more scientifically precise concepts.

 Relocating Kant’s discussion of empirical schematism in the context of eighteenth-century natural history not only helps us to better understand the nature and function of empirical schemata, but also leads to a greater appreciation of the way that Kant’s solution to problems within the critical philosophy can be fruitfully extended to the methodological problems in the emerging life sciences of his time. In particular, I want to suggest that Kant’s account of empirical schematism can explain how the diagrams and illustrations that so often accompanied works of natural history convey general information despite the particularity of these images.

 Before turning to Kant’s account of empirical schematism, I would like to begin by motivating the connection I see between this account and methodological problems in natural history. I do this by turning to Albrecht von Haller’s preface to the German translation of Buffon’s *Histoire Naturelle* (1750).[[3]](#endnote-3) This is an especially important text for my purposes, because we can be almost certain that Kant read it. But more than this, echoes of Haller’s preface can be found throughout the first *Critique*. Indeed, the very language that Kant uses to characterize a schema, as an “outline” (*Umriss*) or “sketch” (*Entwurf*), likely has its source in this text.

**1. The Generality Problem in Eighteenth-Century Science**

In the Preface to the German translation of Buffon’s *Histoire Naturelle* (1750)

Albrecht von Haller writes the following:

A theoretician of Nature acts like a land surveyor, who begins a map on which he has determined some locations, but lacks the positions of other places in between. [He] nevertheless makes an outline (*Umriss*), and according to half-certain reports, indicates the remaining towns, of which he still has no mathematical knowledge. If he had made no sketch (*Entwurf*) in which he combined the certain and uncertain [components] in one composition, then his work of determining more exactly the locations and boundaries which still remained would be much more difficult and almost impossible. Indeed, it would not be possible, because [the work] would have no coherence, and would constitute no whole. (1750/1981, 304)

As anyone familiar with the history of science knows, Cartesians and Newtonians had given hypotheses a bad name in the methodology of science. Here, Haller is mounting a strong defense of them, particularly in the context of the topic of the book he is introducing, natural history.

 For Haller, the demand for certainty stands in the way of scientific progress. While Haller grants that hypotheses are “not the truth,” they “are the clues which lead to novelty and truth” (1750/ 1981, 301). As evidence for the utility of hypotheses, Haller cites how “Kepler’s conjecture, which has been proved to be unfounded” nevertheless led to Kepler’s laws.[[4]](#endnote-4) Perhaps more significantly for our present purposes, he maintains that advances in botany would have been impossible without “arbitrary, ruling principles” for dividing plants in classes, genera, and species, citing Cesalpino’s systematization of plants on the basis of organs of fructification and Linneaus’ later systematization of plants in terms of the numbers of pistils and stamen.

 We can be almost certain that Kant read Haller’s Preface. Buffon’s *Histoire Naturelle* was one of the main texts that Kant used for his course on physical geography and Kant specifically mentions this text in his 1757 advertisement for the course.[[5]](#endnote-5) The translation for which Haller wrote the preface, which first appeared in 1750, was the only available German translation until the 1760s and even after other translations became available, it was still the “authoritative” German edition.[[6]](#endnote-6)

 Furthermore, Kant’s engagement with Haller’s Preface is manifest throughout the *Critique of Pure Reason*. When Kant writes in the Preface to the B-Edition that Galileo, Toricelli and Stahl “comprehended that reason has insight only into what it itself produces according to its own design” and that reason must “compel nature to answer its questions” in accordance with that design (1781-87/ 1998, B xiii) he is echoing Haller’s remark that “a system, or the destruction of one, poses an innumerable quantity of questions which we can pose to Nature, and which it very often answers” (1750/1981, 304). In the Appendix to the Transcendental Dialectic, Kant continues to echo Haller’s remarks on the role of hypotheses in science, specifically in the context of building a systematic whole of cognition.

 We also detect Haller’s influence on Kant’s characterization of schemata in the first *Critique*. Haller does not use the term “schema” (*Schema*) in his preface, but, in the text quoted above, he appeals to the analogy of a surveyor’s map in order to explain the usefulness of hypotheses in providing “an outline” (*Umriss*) or “sketch” (*Entwurf*) of how various cognitions fit together in a whole (1787/ 1981, I, 112). And it is precisely these terms that Kant uses to describe schemata in the third chapter of the Doctrine of Method, entitled “The architectonic of pure reason.”

 In this chapter, Kant explains that systematic unity is required to transform “ordinary cognition into science” (1781-87/ 1998, A832/ B860). He distinguishes two kinds of unity: architectonic unity, which results from the organization of cognitions in accordance with an a priori idea and technical unity, which results from merely empirical interests (1781-87/ 1998, A833/ B861). Kant writes, “What we call science, whose schema contains the outline (*den Umriss*) (*monogramma*) and the division of the whole into members in conformity with the idea, i.e., *a priori*, cannot arise technically, from the similarity of the manifold or the contingent use of cognition *in concreto* for all sorts of arbitrary external ends, but arises architectonically, for the sake of its affinity and its derivation from a single supreme and inner end, which first makes possible the whole…” (1781-87/ 1998, A833-4/ B861-2). A schema, in this context, is an outline of how various cognitions fit together in a systematic whole; Kant defines it as “an essential manifoldness and order of parts determined a priori from the principle of the end” (1781-87/ 1998, A833/ B861). A schema that is “not outlined (*entworfen wird*) in accordance with an idea” of reason can only yield technical unity.

 I take it, therefore, that if we want to understand the role of empirical schemata in the Kantian critical project, we would do well to pay close attention to the problem in scientific methodology that Haller is engaged with, as this appears to be an important source for Kant’s appeal to schemata. The problem in relation to natural history is this. Naturalists were confronted with an increasing diversity of natural forms. They needed principles to organize their comparison of these forms. While Haller grants that the classificatory principles in botany are arbitrary (e.g., Linnaeus’ appeal to the number and shape of pistils and stamens), he nevertheless thinks that the use of such principles enabled botanists to bring order to an “innumerable multitude of plants” and thereby to “distinguish ten thousand plants more easily and with infinitely greater certainty, than the Ancients did their six hundred” (1787/ 1981, 302). As Haller recognizes, there is simply too much diversity to make any progress in botany through the mere description of individual specimens. One must by guided in advance by a theoretical system. It is this system that allows the theoretician of nature to form an outline or sketch that combines certain and uncertain knowledge into a whole of cognition.

**2: Pure Sensible and Empirical Schemata**

 There is little doubt that Kant’s discussion of the role of schemata in the Doctrine of Method concerns scientific methodology. As we have just seen, Kant is clearly informed by Haller’s Preface when he characterizes a schema as an “outline” *(Umriss*) of the structure of a science, even though his discussion of architectonic unity goes beyond anything we find in Haller.

 However, in the Schematism chapter, it does not look like Kant is concerned with methodological problems in the sciences. Instead, he is concerned with an apparent problem that arises from his commitment to the principle that concepts only have “sense and significance” if they relate to objects. For Kant, a concept relates to an object of intuition when the concept has content that can be intuited in the object: “the concept must contain that which is represented in the object that is to be subsumed under it” (1781-87/ 1998, A137/ B176). This creates a *prima facie* problem for the categories, because qua pure concepts of the understanding, these concepts do not have sensible content. Kant appeals to transcendental schemata to explain how the categories can relate to objects, thus avoiding the charge that they are mere thought entities. Transcendental schemata translate the logical relations contained in the categories into temporal relations that can be intuited.[[7]](#endnote-7) In his discussion of transcendental schemata, Kant is clearly concerned with explaining how the categories can acquire sensible content through which they can be meaningfully employed.

 It is less clear, however, why pure sensible and empirical concepts need schemata if we are focused only on this semantic problem.[[8]](#endnote-8) One can establish the meaningful employment of a pure sensible concept, e.g., the geometrical concept of a triangle, by constructing an instance of the concept (e.g., drawing a triangle). And, as Kant points out in the third *Critique*, to demonstrate the objective reality of an empirical concept, one need only provide an example (1790/ 2000, 5: 351).[[9]](#endnote-9) Yet, Kant claims that schemata must “ground” pure sensible and empirical concepts (1781-87/ 1998, A141/ B180). This is because, even though it is easy to demonstrate the objective reality of these concepts by giving concrete examples, we cannot *identify* the sensible content of these concepts with particular examples, as at least some of Kant’s empiricist predecessors tried to do. The way that Kant puts this point is by saying that “no image of a triangle would ever be adequate to the concept of it” and “even less does an object of experience or image of it ever reach the empirical concept” (1781-87/ 1998, A141/ B180). The worry that Kant raises here is epistemological, not semantic (or more precisely, he is aware that any answer to the semantic question—how concepts acquire sensible content— must address the generality problem, which is an epistemological problem).

 The epistemological problem becomes clearer if we turn to Kant’s discussion of mathematical cognition in the “Doctrine of Method.” The method of mathematics, as Kant notes, is the construction of concepts (1781-87/ 1998, A713/ B741), where to construct a concept is “to exhibit a priori the intuition corresponding to it” (1781-87/ 1998, A713/ B741). But the product of construction—e.g., a Euclidian diagram—is always an individual object. This gives rise to the following question. How can mathematical reasoning that is based on an individual figure support *universally valid* mathematical judgments? According to Kant, reasoning on the basis of the individual is nevertheless universally valid because in generating the figure, “we have taken account only of the action of constructing the concept, to which determinations, e.g., those of the magnitude of the sides and the angles, are entirely indifferent, and thus we have abstracted from these differences, which do not alter the concept of the triangle” (1781-87/ 1998, A714/ B742). In other words, it is not the figure itself, but the “action of construction” that grounds mathematical judgments.[[10]](#endnote-10) Although Kant refers to the individual drawn figure as the “schema” of the concept, what is relevant is the *rule* for constructing this figure. Thus, the sensible content of pure sensible contents must be understood in terms of rules for constructing these concepts (schemata) and not particular instances of the concept (e.g., a particular drawn figure). Otherwise, Kant thinks we would not be able to explain how reasoning on the basis of an individual figure could support general mathematical judgments.

 The generality problem is even more pressing in the case of empirical concepts; as Kant puts it, “even less does an empirical object or image of it ever reach the concept” (1781-7/1998, A141/B180). Unlike pure sensible concepts, we have to form empirical concepts on the basis of experience. By contrast, we “make” pure sensible concepts a priori. In defining a pure sensible concept, one is at the same time providing the schema for this concept, e.g., the definition of a triangle is “a figure enclosed by three straight lines with equally many angles,” which serves as a rule for the synthesis of space through which I construct the object of this concept (1781-87/ 1998, A729/ B 757). The object that one exhibits a priori through this synthesis “can surely contain neither more nor less than the concept, since through the explanation of the concept, the object is originally given” (1781-87/ 1998, A730/ B758). But we *encounter* empirical objects; we do not construct them. And our empirical intuitions of these objects bring with them a rich particularity that is absent in the pure case. We are thus in the position of trying to determine which of these many features are relevant when subsuming objects under concepts.

 It is tempting to think that Kant is primarily concerned with the question of how we first form empirical concepts on the basis of sensible representations of these particulars. This was, after all, a serious problem for Kant’s empiricist predecessors, especially to the extent that they tried to reduce all meaningful ideas to particular ideas of sense. Thus, Berkeley, who rejects Locke’s account of abstract ideas, must explain how a particular idea can “become[] general by being made to represent or stand for all other particular ideas of the same sort” (1710/1999, 13-4).

 Kant agrees that concepts that lack sensible content are empty. But Kant’s problem is different precisely because he distinguishes the intuitions through we are given particular objects and the concepts through which we represent these objects in thought. The content of a concept, for Kant, cannot be a particular intuition that “stands for” other particulars, because an intuition is a different kind of representation from a concept. Concepts are essentially general representations that are structured systematically, but the sensible intuitions through which we are given objects are singular and immediate representations (1781-87/ 1998, A32/ B47). The structure of intuitions is spatio-temporal, not logical.

 To see what the problem is, it will help to recall that Kant subscribes to the traditional, Aristotelian logic of concepts, according to which concepts are organized in genus-species hierarchies governed by the notion of concept containment, which in turn underwrites syllogistic reasoning.[[11]](#endnote-11) The concepts contained *within* a given concept include those that are higher on the conceptual tree as well as those that serve to differentiate the concept from others that fall under the same genus. <Human>, for example, contains <animal> and <rational>. In addition to the partial concepts or marks that are contained within a concept, any concept will have a logical extension: the further *concepts* that fall under it on a concept hierarchy. The generality of concepts is fundamentally tied to the way in which they relate to each other on a conceptual tree. This organization enables syllogistic reasoning, because whatever is contained in a higher concept is also contained in the lower concepts that fall under it. At this point, one should clearly see why Kant cannot identify the content of a concept with a particular intuition. Quite simply, this would not support the systematic structure that is essential to concepts.

 Here, it will help to step back to see that Kant is juggling two different generality problems with respect to empirical concepts. The first problem is that we are confronted with an overwhelming diversity of natural objects, which means there is a bigger gap between empirical concepts and empirical objects than between pure sensible concepts and their objects (where the definition of a pure sensible concept provides one with the rule of synthesis for constructing an instance).  Unlike the figures that the geometer can construct, which are instances of concepts like <triangle> or <circle>, empirical objects are given to us in all their messy detail, and it is not obvious which of their many properties are salient for classificatory purposes. As Haller notes, the natural historian, in constructing a system of nature “lacks [the] positions of other places on the map” (1750/1981, 304).

 The second problem is more philosophical and logical. Kant is aware that although concepts must have sensible content in order to be meaningful, this content cannot be identified with particular empirical objects or images, on pain of failing to fit into the logic of concepts we discussed above. In the next section, I explain how Kant’s account of empirical schemata addresses these problems.

**3. Empirical Schemata, Spatio-temporal Form, and the System of Nature**

 Kant begins the Schematism chapter by claiming that “[i]n all subsumptions of an object under a concept the representations of the former must be **homogeneous** with the latter, i.e., the concept must contain that which is represented in the object that is to be subsumed under it” (1781-87/ 1998, A137/ B176, emphasis in the original). Kant then gives the example of the empirical concept of a plate, which “has homogeneity with the pure geometrical concept of a circle, for the roundness that is thought in the former can be intuited in the latter” (1781-87/ 1998, A137/ B176) The empirical concept plate includes the mark <circular/round>, which reflects the spatial form of most plates. In other words, Kant thinks that the requisite homogeneity, or shared content, between concepts and intuitions is secured through sensible rule for the determination of the spatio-temporal form of objects.

 Although objects are always particular, the rules of synthesis directed at the spatio-temporal form of objects are general (e.g., the schema for the concept <circle> is a general rule for the synthesis of space). Thus, there is no special application problem in the case of empirical concepts because “the concepts through which the object is thought in general are not so different and heterogeneous from those that represent it *in concreto*” (1781-7/1998, A138/ B177). An object represented *in concreto* has a certain spatio-temporal form. Any concept through which the object is thought in general will include as part of its content conceptual marks that reflect rules for the *spatio-temporal determination of objects*. The sensible content of a concept—through which it relates to particular objects—is not a particular image of an object, but is the rule, or schema, for determining the spatio-temporal form of the objects that fall under the (non-logical) extension of the concept.

 We can see how this works if we turn to Kant’s example of the concept of a dog and its corresponding schema. Kant writes: “The concept of a dog “signifies a rule in accordance with which my imagination can specify (*verzeichnen kann*) the shape of a four-footed animal in general, without being restricted to any singular shape that experience offers me or any possible image that I can exhibit *in concreto*” (1781-87/ 1998, A141/ B180). This example can be misleading for the contemporary reader who may not recognize that central importance of—and the considerable debate surrounding—the concept <quadruped> in eighteenth-century science.[[12]](#endnote-12) Understood against that backdrop, however, it is clear that Kant is giving an example that readers of his time would have immediately recognized in the context of natural history.[[13]](#endnote-13) This background is crucial for understanding Kant’s example. The concept <quadruped> is, for Kant and his contemporaries, part of the content of the concept <dog>. It is also of central importance in the further specification of the concept <animal> on both Aristotelian and early modern taxonomies. The concept <quadruped> not only supports inferences (e.g. If I know that all quadrupeds are animals, and I know that dogs are quadrupeds, then I know that all dogs are animals). It also serves as a “rule for the synthesis of intuitions.” That is, there is a non-logical employment of the concept in relation to perception. It is in this sense that the concept <quadruped> functions as a schema.[[14]](#endnote-14) Just as the schema of the concept of a triangle “is a rule of the synthesis of imagination *with regard to pure shapes in space*,” the schema of the concept dog is “a rule in accordance with which my imagination can specify *the shape* of a four-footed animal in general” (1781-7/ 1998, A141/ B180, italics added).[[15]](#endnote-15)

 Unlike a pure sensible schema, however, it is not a rule or procedure for constructing instances of the concept a priori (although, as we will see later, it does serve in an analogous way when used to produce an image of the concept in the form of an illustration). Instead, it is a rule that is involved in any recognition of a dog in perception, which can thus connect the content of one’s perception with the content of the concept. Katherine Dunlop describes the schema that enables us to register the shape of a quadruped as follows: “We might think of the rule as prescribing the shape—head and tail joined to a horizontal cylinder, which rests on four vertical cylinders—that is common to all quadrupeds” (2012, 108).[[16]](#endnote-16) There is, in other words, a spatial organization of parts that is the same for all quadrupeds: the relationship of the limbs to the torso, the torso to the head, and the kind of bilateral symmetry that allows for the coordination of limbs in locomotion. Thus, the conceptual mark <quadruped> not only functions inferentially, but also serves as a rule for the synthesis or combination of the representations of the parts of the animal as they are presented to the subject spatio-temporally. It is because this mark serves as a rule for the perceptual recognition of a dog *and* is contained in the concept of a dog as it figures in a system of concepts that one can “subsume” the perception of the object under the corresponding concept.

 Kant’s answer to the question of how intuitions and concepts can have any shared content at all is clearly informed by the methodological problem with which Haller is concerned, namely, formulating principles for the systematic organization of sensible particulars. One must recall that most advances in early modern taxonomy were made on the basis of classificatory principles that reflected resemblance of *form*. Thus, what Kant recognizes is that it is in virtue of the shared spatio-temporal form of objects that we can connect our intuition of objects with the organization of concepts in a system of nature. Although Kant uses a zoological example in the Schematism chapter—the way that the mark <quadruped> connects the intuition of a dog with the concept of a dog as it figures in a system of concepts—we can see his point equally well if we look at the way in which Linnaeus’ system of botanical classification works in relation to the intuition of particular plants.

 It is worth turning to Linnaeus’ sexual system of classification because both Haller and Kant cite Linnaeus in their discussions of the importance of guiding principles for the observation and systematization of nature. As we saw earlier, Haller cites this as one of his examples of the importance of “ruling principles” in systematic botany. And in “The Use of Teleological Principles in Philosophy,” Kant likewise cites the importance of Linnaeus’ “principle of the persistence of the character of the pollinating parts of plants,” for “the systematic description of nature of the vegetable kingdom” (1788/ 2007, 8:161). It is in the same context that Kant writes that it is “certain that nothing of a purposive nature could ever be found through mere empirical groping without a guiding principle of what to search for; for only *methodically* conducted experience can be called *observing*” (1788/ 2007, 8:161).

 On Linnaeus’ system, plants were classified in terms of the number, arrangement, and length of stamens and pistils. Linnaeus’ principle of classification is at the same time a rule for directing one’s attention to the *shape* and *number* of parts of observed plants. And although early modern naturalists often disagreed about which character(s) to prioritize in their classificatory systems, they nevertheless largely agreed in their focus on observable morphological characters. Thus, for Kant, the very marks that most eighteenth-century natural historians emphasized in their classificatory system of concepts are those that reflect the spatio-temporal form of objects.[[17]](#endnote-17) These marks can thus serve as “schemata” when they are used to determine intuitions (i.e., when they provide a method or rule for perceptually attending to certain aspects of the object’s form in accordance with the concept), thus bridging the gap between concepts and intuitions.

 Although empirical schemata are not rules for a priori construction, they are rules for the determination (or better “delineation”) of the spatio-temporal form of empirical objects. As such, they are meant to capture general spatial (and in some cases temporal) relations of the parts of the object. In his discussion of comparative anatomy in the third *Critique*, for example, Kant writes:

The agreement of so many genera of animals in a certain common schema, which seems to lie at the basis not only of their skeletal structure but also of the arrangement of their other parts, and by which a remarkable simplicity of basic design has been able to produce such a great variety of species by the shortening of one part and the elongation of another, by the involution of one part and the evolution of another, allows the mind at least a weak ray of hope that something may be accomplished here with the principle of the mechanism of nature, without which there can be no natural science at all. (1790/ 2000,5:419)

As I see it, Kant here imagines the mechanism of nature as employing the “common schema” of animal forms in much the same way that a geometer would employ the schema of a pure sensible concept. The schema of a circle is a rule that the geometer can use to construct a circle of any size; one can vary the size of the generated circles by varying the length of the line segment that is rotated around a fixed point. And, as we see in this passage, Kant considers how nature might have produced the great variety of species with *a basic design* through “the shortening of one part and the elongation of another, by the involution of one part and the evolution of another” (1790/ 2000,5:419). Just as Kant describes the schema of a science that is outlined a priori as capturing “the place of each part and its relation to the others” (1781-7/ 1998, A645/ B 673), empirical schemata reflect *empirically* discovered patterns of organization (the basic design or designs) among the parts of natural objects in virtue of which they can be connected to each other in a logical system of nature on the basis of observed similarities.

**4. Empirical Schemata and the Circularity Problem**

 To further explain and motivate my interpretation, I would like to briefly situate it with respect to Béatrice Longuenesse’s influential interpretation of empirical schemata, which has been revised and defended by Hannah Ginsborg. Both Longuenesse and Ginsborg are concerned with providing a Kantian answer to the question of how we form empirical concepts. In an oft-cited passage in the *Jäsche Logic*, Kant suggests that we form the concept of a tree after reflecting on what several trees, a spruce, a willow, and a linden, have in common and abstracting from their differences (1800/1992, 9: 94-5). But Kant’s account raises an obvious circularity worry. Grouping these particular objects together as the appropriate ones to compare seems to presuppose that one *already* possesses the concept <tree>.

 Longuenesse addresses this problem by developing an interpretation of empirical schemata as *pre-conceptual* rules that guide association. According to Longuenesse, empirical schemata are “rules of apprehension” that enable one to detect relevant similarities among objects prior to the formation of empirical concepts by “privilege[ing] certain marks and leav[ing] aside others” in the perception of these objects (1998, 118). Thus, for Longuenesse, we form empirical concepts by reflecting on the empirical schemata that guide our perception of objects. But this merely invites the question of how we first form empirical schemata. One can worry that Longuenesse has simply relocated the circularity problem to the level of empirical schemata.[[18]](#endnote-18)

 In defending the interpretation of empirical schemata as pre-conceptual rules that guide the apprehension of objects, Hannah Ginsborg (2006) appeals to natural dispositions to associate, which are combined with what she calls a “primitive” feeling of normativity, in order to explain how we non-circularly form empirical schemata. On Ginsborg’s interpretation, Kant can agree with the Humean who appeals to natural dispositions to associate in order to explain how we first group together certain objects (e.g., a spruce, a willow, and a linden) prior to possession of the concept that reflects what these objects have in common. But as Ginsborg reconstructs Kant’s account, this disposition becomes a schema when one takes it as providing one with *a rule* for association. The feeling that one is associating as one ought to—that one’s activity is rule-guided—is primitive, precisely because this feeling is prior to the possession of the explicit rule (concept) that would determine the correctness of one’s associations (2006, 51). One then forms a concept that reflects this rule, e.g. the concept <tree>, by reflecting on what the objects that the schema has led one to associate have in common (and abstracting from their differences).

Of course, the problem of empirical concept formation is not unique to Kant, and it may be that any account of this process that avoids concept nativism must ultimately appeal to natural dispositions to associate. Furthermore, the general characterization of empirical schemata as perceptual rules is certainly right. What I want to reject is the thought that Kant’s account of empirical schematism is directed at the problem of empirical concept formation in the sense that Longuenesse and Ginsborg have in mind (or that it should be extended to this problem) and thus the claim that empirical schemata are rules for *associating* sensible representations that rest on natural dispositions.

 Instead, empirical schemata are perceptual rules that are specifically directed at the synthesis of the spatio-temporal, and especially spatial, form of objects. The schema of a dog is a rule for delineating *the shape* of a dog. Spatial form is important because the mark that reflects this form, <quadruped>, is central to the system of concepts on which dogs were classified in early modern taxonomy. But it is also central to the intuition of a dog.[[19]](#endnote-19) To perceive that something is a dog is, *inter alia*, to perceive that there is a certain spatial relationship and organization of its parts. This is not to deny that natural dispositions may also lead one to privilege spatial form in the associations that first lead one to group objects together. But the normativity of empirical concepts, for Kant, largely depends on their systematic organization. The pressure to systematize concepts and to search for the characteristics of objects that can accommodate such a system force us to attend to the form of objects in ways that often go beyond those to which our natural dispositions initially lead us.

 This, in turn, means that schemata cannot simply be reduced to natural dispositions to associate (even if accompanied by a feeling of normativity). Many of the features that one might *associate* with a dog (e.g., that they are slobbery, furry, chase balls, and so on), are irrelevant from the perspective a taxonomic system. In his lectures on physical geography, for example, Kant further specifies quadrupeds in terms of the shape of their feet and number of their toes; dogs are five-toed quadrupeds (1802/2007, 9:333-4). These are features that belong to the observable form of objects, but are not ones that are privileged in most associations. The same point applies to the shape and number of the reproductive parts of plants, which determines their classification on the Linnaean system. As Haller notes, previous naturalists “frequently did not note at all the shape, number, and position of the blossoms, nor their sepals, stamens, and pistils, nectar-containers, or the partitions of the fruit” in their descriptions of plants, and for this reason, they failed to bring “order” to their classifications (1787/1981, 302).

**5. Empirical Schemata and Scientific Illustrations**

 An important advantage of relocating Kant’s account of empirical schemata in the context of methodological problems in the life sciences is that we can better appreciate that his account has the resources for addressing some of these problems. In particular, I want to suggest that Kant’s discussion of empirical schematism can be fruitfully extended to the generality problem as it arose in relation to the use of diagrams and illustrations in early modern science: viz., how can the use of diagrams and illustrations, which are always particular images, support the general judgments of science? The Kantian answer to this question-- that it is not the images themselves but rather the general rules in accordance with which they are produced that grounds judgment—anticipates a point made by contemporary historians of science interested in the rise of “scientific realism” in the pictorial representations that accompanied early modern science.[[20]](#endnote-20) This kind of realism is not the result of trying faithfully to reproduce a particular specimen in all of its rich detail, but requires conventions and techniques for abstracting from such particularity in order to highlight the general features of specimens on the basis of which they can be recognized and classified.[[21]](#endnote-21)

 Before turning to this problem and the Kantian answer to it, I would first like to suggest that we have some reason to think that Kant had scientific illustrations in mind in his discussion of empirical schemata. There are at least two reasons we might think this. First, as Michael Friedman (1985, 2012) and Lisa Shabel (2003, 2006) have convincingly argued, Kant clearly has Euclidian constructions in mind when discussing the exhibition of pure sensible concepts, so it is not a stretch to think that he would have had in mind scientific illustrations when considering the exhibition of at least some empirical concepts.[[22]](#endnote-22) In fact, in his *Lectures on Pedagogy*, Kant explicitly connects illustrations in natural history with instruction in mathematics. Kant writes that once children have learned to read, they can be given “a suitably constructed so-called”with which they “can make a beginning with botanizing, with mineralogy, and the description of nature” (1803/ 2007, 9:474). The *Orbis pictus* to which Kant refers is the *Orbis* *Sensualim Pictus* (1658/1887), published in both Latin and German, which was a popular children’s textbook. It included many pages that paired descriptions of natural objects with illustrations. Kant indicates that these illustrations are useful not only for learning natural history, but also because sketching the depicted objects requires instruction in mathematics. Kant writes that “[s]ketching these objects provides the occasion for drawing and modeling, for which mathematics is needed” (1803/ 2007, 9:474). This give us good reason for thinking that Kant would have linked scientific illustrations to the exhibition of empirical concepts, as he himself notes the parallels between diagrams in mathematics and illustrations in natural history.

 Second, as his *Lectures on Pedagogy* shows, Kant clearly recognized the important role of illustrations and diagrams in learning concepts in natural history (which includes botany, mineralogy, zoology) and geography. We must recall that many of the objects of study in the emerging life sciences would not have been directly accessible to most people, including most naturalists. Instead, descriptions and accompanying illustrations would have been the only source of acquaintance with these objects for Kant and his contemporaries. Thus, when Kant writes that the schema of the concept dog indicates a rule for specifying the general shape of a quadruped, “without being restricted to any single shape that experience offers me, **or any possible image that I can exhibit *in concreto*** (1781-7/ 1998, A 141/ B 180, emphasis added), it is quite likely that the “images” he has in mind are the illustrations accompanying works of natural history. But this also means that Kant would have recognized that such images are subject to the generality problem.

5.1 A methodological problem for eighteenth-century scientific illustrations

 Eighteenth-century naturalists aimed to make their illustrations as correct as possible. But, as Lorraine Daston and Peter Gallison argue, correct depiction was not a matter of fidelity to the individual, but a matter of capturing the essential form of the specimen (2007, 67-8). This meant that unlike earlier Renaissance artists who tried to capture individuals in all of their particularity—or 17th century naturalists who extended this in their desire to capture the anomalous, monstrous, and irregular—eighteenth- century naturalists wanted to depict the general form of specimens, that which was characteristic or typical. They recognized, however, that no individual specimen accorded perfectly with the underlying type. Naturalists thus developed pictorial conventions that governed the production of images in order to abstract from the particularity of the specimens they observed and to represent the general features of these objects.

 Brian Ogilvie traces the use of such pictorial conventions to the work of Renaissance physician and naturalist Leonhart Fuchs (Ogilvie 2006, 194-8). Fuchs criticized other Renaissance naturalists for focusing on the peculiarities of individual specimens, and for depicting them in such a way that certain parts were obscured. The very techniques that artists employed to render their drawings as life-like as possible, namely, shadowing, foreshortening, and the perspectival rendering of specimens, often obscured or concealed the features of objects of most interest to the naturalist. Even though these drawings were more realistic, Fuchs did not think that they “correspond[ed] accurately to the truth” (Ogilvie 2006, 195). The “truth” at stake, as Ogilvie notes, was that of the naturalist, not the artist.

Fuchs’s work marked an important shift from naturalistic realism to what Ogilvie describes as a new kind of scientific realism, one that was concerned with depicting the essential characteristics of specimens in such a way that systematic comparisons were possible (2006, 196).[[23]](#endnote-23) To get at the difference between these two approaches, one need only note that Fuchs’ illustrations depicted plants as simultaneously bearing fruits and flowers. While not naturalistically realistic, this information would be more useful to the naturalist interested in the results of observations of plants over time. In addition to depicting the roots, stalks, leaves, flowers, and fruits of a plant in a single image, Fuchs rejected the artistic conventions of the craftsman—the “shading and other artifices that painters sometimes employ to win artistic glory”—in favor of images that were presented in “a panoptical fashion” (2006, 195-6). As Ogilvie explains, “Fuchs’s illustrations depicted plants spread out, with branches and leaves pushed to the side so as not to obscure other parts of the plant” (2006, 196).

 Eighteenth-century botanical illustrators likewise employed certain methods for highlighting the typical properties of plant specimens, where typical properties were defined in terms of Linnaeus’s sexual system of taxonomy (Nickelsen 2006). On the Linnaean system, the number and arrangement of male and female plant organs (pistils and stamens) determined the order and class of flowering plants. The draftsmen that naturalists employed did not just need artistic skill, they had to be instructed in the principles of botanical classification. Thus, in his popular manual for draftsmen, the *Botanical drawing-book* (1788), James Sowerby begins with a discussion of the principles of Linnaean classification, introducing the organs of fructification with descriptions and accompanying plates (Nickelsen 2006, 11). As Kärin Nickelsen emphasizes, “Sowerby writes nothing of drawing techniques or shading but, after giving a summary of the principle parts of the stamen, lists the possible shapes of these organs, which he carefully describes” (2006, 11)

 I would like to focus on two methods that botanical illustrators employed to highlight the taxonomically relevant aspects of the specimens they depicted. One method was to distort the scale of certain parts in order to depict them more clearly. For example, in his illustration of a Coltsfoot, German botanist and botanical illustrator Johann Zorn (1739-1799) enlarges the tubular florets at the center of the flower head in order to depict its five petals, “thereby distorting the scale of the drawing in this section” (Nickelsen 2006, 4). Botanical illustrators also employed colors that would not be natural to the specimens in order to draw the viewer’s attention to certain parts of the plant. But because color was not considered a taxonomically relevant trait on the Linnaean system—it was accidental rather than essential—the use of color in this way was justified. For example, in an illustration of sweet vernal grass, German botanist Jacob Sturm, painted the stamens bright red in order to draw the viewer’s attention to this feature (Nickelsen 2006, 7). “The images,” as Nickelsen explains, “were not intended to render the outward appearance of living plants but were meant to communicate typical features of plant species in a model-like way” (2006, 5).

 Kant himself clearly recognized the importance of having “models” of species that were idealized in this way. In §17 of the *Critique of the Power of Judgment*, Kant describes the normal idea of a species, which serves as the archetype of a species. Kant notes that the normal idea “must take its elements for the figure of a particular species from experience,” but it does not correspond to any particular specimen. In language that mirrors that of the Schematism chapter, Kant explains that “no separate individual is adequate” to this idea, but only the species as a whole (1790/ 2000, 5:233). Nevertheless, Kant claims that the idea “can be represented fully *in concreto* as an aesthetic idea in a model image” (1790/ 2000, 5:233). This image, in turn, is indispensible for the “correctness in the presentation of the species” in fine art, and is thus a necessary (though not sufficient) condition for the beautiful depiction of the species (1790/ 2000, 5:235).

 There is perhaps no better example of the communication of underlying form through a “model image” than the drawings by Georg Ehret that accompanied Linnaeus’ *Hortus Cliffortanius (*1737). As Daston and Gallison note, Ehret’s drawings of *Gladiolus foliis linearibus* leaves “do not mimic those of any particular specimen,” instead, they “refer back to the essential leaf forms that, according to Linnaeus, were the underlying types of all leaves observed in individual plants” (2007, 60). That is, they refer back to the first figure included in the book, which was a schematic representation of leaf types for botanical classification, and which served as “a visual key to the illustrations of species that followed” (2007, 60). Ehret thus highlights the linear shape of the *Galdiolus foliis linearibus* leaves (one of over 50 shape-types depicted in initial figure).

 As we have seen, the generality problem was an especially pressing one for early modern naturalists (not to mention anatomists and antiquarians).[[24]](#endnote-24) They were in search of principles for the classification of the increasing diversity of specimens with which they were confronted. But even with classificatory principles in hand, as in the case of Linnaeus’ sexual system, the illustrations that played an indispensible role in communicating information needed to highlight the taxonomically relevant features of the objects they depicted. Naturalists and their illustrators thus developed a number of techniques in order to bridge the gap between the inherent particularity and richness of observed specimens and the general type or form of these specimens. They simultaneously needed to abstract from the “irrelevant” features of specimens while highlighting the taxonomically relevant ones, where this often involved producing illustrations that were not physically accurate.

 If we connect this to Kant’s discussion of empirical schemata, we see that, as Kant suggests, it is the rule that guides their production that enables images to underwrite the systematic comparisons of objects in early modern scientific practice. Take, for example, Linnaeus’ method for determining the class and order of plants. This connects nicely with Kant’s discussion of the difference between a schema and an image. Kant claims that if I place “five points in a row, . . . . . this is an image of the number five” (1781-7/ 1998,A 140/ B 179). A schema for generating numbers, by contrast, is not an image, but “the representation of a method for representing a multitude (e.g., a thousand) in accordance with a certain concept” (1781-7/ 1998, A 140/ B 179). The schema on the basis of which a plant is classified—which is also what guides the illustrator in the production of images of the plant—is the representation of a method for delineating the shape and number of its reproductive parts.

 Although scientific illustrations are images, and thus individual intuitive representations, they can nevertheless be used to communicate general information. In the same way that a diagram in Euclidian geometry can be used to depict general spatial relations (e.g., of containment, congruence, etc.), the illustration of a species in eighteenth century natural history served to depict the spatial organization of the parts and defining characteristics of its members. The function of these images and the rules that produced them was not *necessarily* for the recognition of objects (i.e. to first recognize that something is a dog or a plant, although in some cases it may serve this function), but rather to draw the viewer’s attention to taxonomically (or otherwise scientifically) relevant properties of these objects.[[25]](#endnote-25)

**6. Conclusion**

Kant’s interest in the metaphysical foundations of Newtonian mechanics and Euclidian geometry has long been recognized as a driving force in his critical philosophy. But as a number of scholars have more recently argued, Kant was equally interested in the philosophical and methodological issues raised by the life sciences of his time.[[26]](#endnote-26) In this paper, I have argued that we can make further progress in understanding Kant’s account of empirical schematism by recognizing the way that it is informed by—and speaks to—some of these problems.

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1. Chipman (1978), Young (1988) and Allison (2004) are concerned with the first of these questions; Sellars (1978) and Matherne (2014, 2015) are primarily concerned with the second; and Longuenesse (1998) and Ginsborg (2006) address the third. [↑](#endnote-ref-1)
2. For example, Samantha Matherne writes that, “the concept ‘dog’ indicates that dogs have various properties, for example, being furry, four-legged, an animal, etc.” while “the schema represents how those various properties appear together in a whole” (2014, 188). But Kant’s characterization of the schema of a dog is specifically focused on the spatial form of the dog, not with marks like <furry>. [↑](#endnote-ref-2)
3. Haller’s preface was published posthumously as the essay, “Vom Nützen der Hypothesen” (Haller 1787). It is this version I have consulted for the German. [↑](#endnote-ref-3)
4. As Sloan notes in his translation of Haller’s preface, the reference appears to be to the “hypothesis of the sun’s attractive virtue” (Sloan 1981, 301, fn. 19). [↑](#endnote-ref-4)
5. Kant (1802/ 2012, 2:4). [↑](#endnote-ref-5)
6. Sloan (1981, 296). [↑](#endnote-ref-6)
7. For example, the pure concept of causality is that of the ground/consequent relation. The transcendental schema of this concept is that of necessary succession. The temporal relation of dependence that holds between the state in time at which something happens and the preceding state in time is a realization of the purely logical relation of dependence we find between a consequent and a ground. [↑](#endnote-ref-7)
8. For more on the way that schemata address both semantic and epistemological problems, and the potential conflict this creates in the construction of geometrical concepts, see Goodwin (2018). [↑](#endnote-ref-8)
9. One might think that this passage indicates that in third *Critique*, Kant no longer thinks that empirical concepts need schemata. I do not think that this passage indicates any change in Kant’s view. Instead, I take it that because Kant is squarely focused on the semantic question in this passage (the context of which is an explanation of how rational ideas acquire sensible meaning through symbolization), he does not need to highlight the fact that empirical concepts have schemata, since this problem does not arise for them. As I make clear in what follows, it is methodological and epistemological worries that primarily explain Kant’s appeal to empirical schemata, rather than the semantic question. [↑](#endnote-ref-9)
10. Michael Friedman (1985, 2012) and Lisa Shabel (2003, 2006) have done important work connecting Kant’s account of pure sensible schemata to the proof-procedures of Euclidian geometry. On Friedman’s interpretation, the schemata of basic geometric concepts are identified with the Euclidian rules for constructing these concepts (2012, 237). According to Shabel (2003), the diagrams used in the course of Euclidian proofs, even if they are empirical (e.g., actually drawn on paper) count as pure intuitions given their role in mathematical reasoning. As Shabel later notes, diagrams serve to ground the general judgments of geometry in virtue of the conditions of their construction (2006, 100). [↑](#endnote-ref-10)
11. See Anderson (2005, 2015, esp. Ch. 2) for further discussion of concept containment in the traditional logic, the rules of division, and the relation to syllogistic inference. [↑](#endnote-ref-11)
12. There was considerable controversy surrounding Linneaus’ choice to place humans among the quadrupeds in the 1735 *Systema Naturae* (Schiebinger 1993, 386). But there were also debates over the best way to further specify the concept <quadruped> itself. Some naturalists, such as John Ray, further specified quadrupeds in terms of the shape of their feet. Kant’s own classification in the *Physical Geography* follows this model (1802/ 2012, 9:333-334). Others, however, did so on the basis of number of teeth (e.g., Linnaeus’ method in the *Systema Naturae* (1735), before the transition to “Mammalia”). Buffon famously rejected the scholastic classification system, especially as employed by Linnaeus, as arbitrary. For more on the Buffon/Linnaeus debate, see Sloan (1976). [↑](#endnote-ref-12)
13. To my knowledge, the only commentator who acknowledges the importance of this context for understanding Kant’s example is Katherine Dunlop (2012). [↑](#endnote-ref-13)
14. Because Kant understands concepts as rules, the distinction between the logical employment of the understanding and its role in intuition via the imagination means that concepts function as rules in two different senses. On the one hand, concepts are inferential rules. If I know that something is a material body, I know that it is extended in space. This is what Kant means when he says that the concept body “serves as the rule for our cognition of outer appearances by means of the unity of the manifold that is *thought* through it” (1781-7/ 1998, A106). But concepts are not just inferential rules for Kant. They are also rules for the synthesis of intuitions. This is what Kant means when he writes that the concept of a body is a rule of intuitions insofar as “it represents the necessary reproduction of the manifold of given intuitions” (1781-7/ 1998, A 106). [↑](#endnote-ref-14)
15. [↑](#endnote-ref-15)
16. Dunlop is primarily concerned with Kant’s account of geometrical concepts and schemata, but she offers this example to explain how empirical schemata allow for the application of higher (more general) empirical concepts to intuitions. Thus, for Dunlop, because the schema of a dog will be a variant of the more general schema of a quadruped, application of this schema to intuition enables one to subsume one’s intuition not only under the concept <dog> but under more general empirical concepts as well <quadruped>, <animal>, etc. Ultimately, she wants to explain how sensible intuitions can “instantiate concepts whose marks cannot be prescribed on the basis of experience” (2012, 108). What I want to emphasize is that marks like <quadruped> can explain the shared content of concepts and intuitions. This mark can function inferentially as part of the content of the concept <dog>, but it can also serve as a rule of the synthesis of intuition in my recognition of an object of intuition as a dog. [↑](#endnote-ref-16)
17. In his discussion of pure sensible and empirical schemata, Kant is specifically concerned with *spatial* form (“pure shapes in space,” “the shape of a four-footed animal”). As I will show in what follows, it is precisely the role of most illustrations to draw our attention to the spatial form of objects. But I do not want to rule out schemata that concern temporal form. For example, Buffon’s “rule of reproduction” for species could be taken as a schema that is directed at spatio-temporal form in an extended sense, as this involves the observation of the *succession* of the species. And an anonymous referee suggests that the typical gait of an animal is a spatio-temporal form. Thus, while we can make better sense of Kant’s examples by focusing on spatial form, I prefer to use “spatio-temporal” form in order to leave open these possibilities. [↑](#endnote-ref-17)
18. Sally Sedgwick (2000) raises this concern. For her response, see Longuenesse (2005). [↑](#endnote-ref-18)
19. One might wonder in what way the schema of the concept <dog> is more specific than that of the concept <quadruped>. Unfortunately, Kant does not provide a clear answer to this question. It is worth noting that when Kant further specifies quadrupeds in the *Physical Geography*, it is in terms of the shape of their feet and number of toes (1802/ 2012, 9:333-334). Thus, the schema of a dog might be more specific than just “four-footed animal in general” if it includes this more detailed spatial information. [↑](#endnote-ref-19)
20. This use of the term “scientific realism” in this sense is from Ogilvie (2006, 196-201). [↑](#endnote-ref-20)
21. See Ogilvie (2006, 196), Daston and Galison (2007, Ch. 2), Moser (2014, 82), and Nickelsen (2005, 5). Daston and Galison use the phrase “truth to nature” to describe the attempt of eighteenth century atlas makers to capture the essential features of a kind or type through pictorial idealization. [↑](#endnote-ref-21)
22. On Friedman’s interpretation, the schemata of basic geometric concepts are identified with the Euclidian rules for constructing these concepts (2012, 237). According to Shabel (2003), the diagrams used in the course of Euclidian proofs, even if they are empirical (e.g., actually drawn on paper) count as pure intuitions given their role in mathematical reasoning. [↑](#endnote-ref-22)
23. See also Moser (2014, 62). [↑](#endnote-ref-23)
24. For discussion of the role of illustrations in anatomy, see Ghosh (2015). For discussion of illustrations of antiquities in early modern science, see Moser (2014). [↑](#endnote-ref-24)
25. The schema thus goes beyond the aesthetic normal idea, because while the latter enables judgments about how well a specimen accords with the archetype of the species, the schema is used to determine species membership. [↑](#endnote-ref-25)
26. See Zammito (1992), Mensch (2013), and Fisher (2007). [↑](#endnote-ref-26)