

The Beauty of Science without the Science of Beauty
Kant and the Rationalists on the Aesthetics of Cognition

Angela Breitenbach

(forthcoming in *Journal of the History of Philosophy*)

Abstract

Claims about the beauty of theories and explanations are often inspired by the Platonic vision that beauty will lead us to truth. By contrast, Kant's aesthetics is commonly regarded as providing the most influential critique of this vision. In this paper I show that this popular contrast is mistaken in important respects. By examining Kant's views in comparison with those of his immediate contemporaries, A. G. Baumgarten and G. F. Meier, I show that the Kantian position offers an important contender to the Platonic ideal, namely, a conception of the beauty of science that is independent of the science of beauty.

1. Introduction

It is common to praise the beauty of theories, the elegance of proofs and the pleasing simplicity of explanations. We may admire, for example, the beauty of Einstein's theory of general relativity, the simplicity of Darwin's idea of natural selection, and the elegance of a geometrical proof of Pythagoras' theorem. Aesthetic judgments such as these have much currency among scientists, and they are employed in the search for knowledge more widely. But while the use of aesthetic judgments in science is widespread, it is not uncontroversial.¹ On one side, such judgments are often inspired by the Platonic vision that beauty and truth are ultimately one. As

Henri Poincaré saw it, science is the “disinterested pursuit of truth for its own beauty,” and it is the “intellectual beauty” of science “which gives certainty and strength to the intelligence.”² Perceiving beauty in science is, on this conception, simply another way of cognizing the true order of nature. Experiencing the beauty of theories and explanations and knowing their truth are two perspectives on one and the same thing, the fundamental structure of reality. On the other side, by contrast, Kant’s aesthetics is commonly regarded as the most influential critique of this vision, a vision that had also inspired many of Kant’s rationalist contemporaries. Kant construes aesthetic judgments as involving the free play of imagination and understanding, and hence as essentially distinct from determinate cognition. For this reason he dismisses the possibility of genuine intellectual beauty. His aesthetics has consequently been taken to support a skeptical approach to the idea of beauty in science, and aestheticians have offered Kantian arguments against ascribing aesthetic merit to theories, proofs or explanations.³

I believe that this popular contrast between the Platonic ideal and its Kantian critique is mistaken in significant respects. Most importantly, it obscures the positive alternative that emerges from Kant’s engagement with the vision so aptly described by Poincaré. On this alternative conception, aesthetic judgments do not themselves provide cognitive access to the truth, and determinate scientific claims do not on their own ground aesthetic pleasure. By contrast, science can be the object of aesthetic judgment if it allows for free reflection and an intimation of that which lies beyond what is strictly represented. Sensible representations as well as theories and explanations can elicit such reflection if they are the products of creative intellectual activity. On the Kantian account, it is these intellectual activities, broadly construed as a creative and open-ended pursuit, that make possible a distinctive aesthetic experience in science.

My aim in this paper is to spell out and develop this alternative conception of the beauty of science. To do so, I begin by considering the views of Kant's immediate rationalist contemporaries, followers of Leibniz and Christian Wolff, who were themselves treading in Plato's footsteps. I focus, specifically, on Alexander Gottlieb Baumgarten, famous for giving aesthetics its name, and his student Georg Friedrich Meier, a prolific writer, set on developing his teacher's ideas (§2).⁴ I concentrate on the two because they were particularly concerned to elaborate a rationalist aesthetics, and because Kant was familiar with key writings of theirs and used their theory of aesthetics as a foil for his own account.⁵ In the subsequent section I examine why for Kant, by contrast with the rationalists, the determinate claims of science are essentially distinct from the reflective judgments of beauty (§3). As usual, examining the details of the historical contrast reveals that the arguments are more complex and the ideas more intertwined than the popular sketch suggests. The comparison brings to light, in particular, that Kant's casual dismissal of the beauty of science in the *Critique of Judgment* is crucially limited. In part disclaiming, in part advancing rationalist insights, Kant's account stands in a mixed relationship to that of his contemporaries. As I argue in the following two sections, his theory provides the resources for an aesthetics of science, broadly construed as a creative intellectual activity. More specifically, his position implies a conception of the aesthetics of scientific representations (§4), and it offers the basis for a more general account including the aesthetics of scientific theories and explanations (§5).

I argue that this alternative conception can answer the challenge that science is too intellectual, and too conceptually determinate, to allow for the free reflection that grounds aesthetic pleasure on Kant's account. In fact, I suggest, the account exposes the close links between Kant's aesthetics and his theory of cognition, and thereby sheds light on the sensible

dimension of the scientific search for truth. To be sure, Kant does not explicitly develop this account himself. But it is one we can construct from the theoretical resources he lays out. Nor does the proposed conception account for all judgments of beauty ever made about science. But it makes sense of a species of pleasure widely recognized as the appreciation of scientific beauty. The Kantian account I propose thus offers a powerful contender to the Platonic ideal by developing a conception of the beauty of science that is independent of the science of beauty (§6).

2. Rationalist connections

How could the perception of beauty give us access to reality? It could if it were itself a form of the cognition of reality. This, in brief, is the idea behind Baumgarten's and Meier's aesthetics. Following Leibniz and Wolff, they construe the perception of beauty in an object as the cognition of the object's perfection, that is, of the internal unity and harmony of the parts within the object as a whole.⁶ More specifically, on their account, to perceive the beauty of an object is to have *sensible* cognition of its perfection; beauty is, in Baumgarten's words, "the perfection of an appearance" and ugliness its "imperfection."⁷

Baumgarten and Meier stay within the Leibnizian-Wolffian framework in characterizing sensible cognition as a clear but confused representation of things, in contrast with clear and distinct rational cognition.⁸ As a form of sensible cognition, the perception of beauty thus consists in recognizing the object's perfection, without achieving the distinct insight that only rational cognition makes possible. In appreciating the beauty of a mountain landscape, for

example, I am aware of the unity and harmony of my perspective on the mountain range, the lake it encloses and the clear sky above, but I do not, thereby, prize apart the distinguishing features of shapes and colors, light and shadow, and perhaps smells and sounds, that make the landscape stand out.

According to Baumgarten and Meier, it is the way in which clear and confused cognitions are achieved, furthermore, that accounts for the special phenomenal character of aesthetic experiences. In perceiving perfection through the senses, they argue, the lower cognitive powers are brought into harmony with one another, which is accompanied by a feeling of pleasure. The perception of beauty is thus a form of objective cognition which speaks to our passions and makes rational insight emotionally accessible. In Meier's words, it gives "flesh and blood" to the mere "skeleton" of the distinct insights of reason.⁹

This, in broad strokes, is Baumgarten's and Meier's cognitivist conception of beauty. One may object to this conception that not all sensible cognition of perfection is equally aesthetically pleasing. Different attempts to represent the same mountain range—Gerhard Richter's black and white painting, "Gebirge," compared with my own sketches, fondly but amateurishly remembering the scenery of a holiday hike—clearly have different aesthetic value. Baumgarten and Meier account for this thought by arguing that sensible cognition can itself be more or less perfect. What can be perfected is that feature which distinguishes sensible from rational cognition, its confused rather than distinct character. While distinctness is achieved by isolating the marks contained in a concept, the confused character of cognition increases as more and more marks are combined in a single representation.¹⁰ The perfection of rational cognition thus aims for abstraction, while aesthetic perfection is achieved by focusing on the specific and by illustration and exemplification. Sensible representation is the more beautiful, on this conception,

the more lively and truthful to the particularity of the object it represents the object's perfection.¹¹

This contrast between the more and less aesthetically perfect character of cognition accounts for the difference between Gerhard Richter's art and my own attempts at drawing. It also explains, for example, the aesthetic difference between Descartes's dry and studied treatise on astronomy in his *Principes de la philosophie*, whose sensible stimulation is limited to a few diagrams, and the literary presentation of the same theoretical content in Bernard Fontenelle's *Entretiens sur la pluralité des mondes habités*.¹² Instead of principles and proofs, set out in quasi-mathematical style, Fontenelle explains the heliocentric model of the universe in the setting of a nocturnal dialogue between a philosopher and a marquise who wonder about the marquise's garden gazing at the stars. Fontenelle's popular account of astronomical insights is detailed and illustrated by examples. On Baumgarten and Meier's account, it is for this reason that Fontenelle's novel, while communicating the same scientific content as *Principes de la philosophie*, is more beautiful than the less extensively clear diagrammatic representations of Descartes. As Meier puts it, it is the richer and more "lively" cognition that "exercises the powers of the mind and thereby touches on the soul."¹³

Baumgarten and Meier thus regard judgments of beauty and cognitive insights as intimately connected. On their account, the experience of beauty is a form of cognition that, just like the more abstract insights of reason, lays bare the structure of reality, while at the same time, and unlike cognition from rational principles, giving rise to aesthetic pleasure. Moreover, according to them, cognition can be perfected aesthetically as well as logically. It may be more or less beautiful just as it may be more or less conceptually distinct.¹⁴ It is this cognitive conception of aesthetics, which grounds the tight connection between aesthetics and science. On

the one hand, we can have principles of beauty and, hence, a science of aesthetics. For we can determinately specify the features that ground aesthetic judgments, features of the object as well as of its representation.¹⁵ On the other hand, the cognitive insights of science can themselves be beautiful. Achieved in the right way, namely, through the extensively clear representations of the senses, objective cognition is a source of aesthetic pleasure. As Meier puts it, the beautiful sciences

are not bound to any specific object of our cognition; rather they can be concerned with theological, philosophical, mathematical, juridical and medical matters etc. ... they are concerned with the special way and manner of cognizing some thing.¹⁶

Baumgarten's and Meier's account thus makes room for the science of beauty as well as the beauty of science. The cognition of beauty is the subject of the science of aesthetics, while the insights of the sciences can be the objects of aesthetic judgments.

3. Kantian divisions

A difficulty with the rationalist account of beauty is that it seems overly intellectualist. Construing the experience of beauty as a form of cognition, whether sensible or non-sensible, does not appear to capture what is so special about aesthetic appreciation, namely, its peculiar relation to the subject and her feeling of pleasure and displeasure. This, in brief, is the objection Kant raises against Baumgarten's and Meier's identification of aesthetic judgment with the

cognition of perfection. Although the exact details of Kant's relation to the aesthetic theory of his rationalist predecessors are a matter of some controversy, two points of disagreement are clear.¹⁷ First, Kant rejects the rationalists' view that we can have access to the fundamental structures of reality either (distinctly) through reason or (confusedly) through the senses. On Kant's transcendental idealist account, cognition requires both intellect and sensibility, and it can give us insight only into appearances and not into the nature of things in themselves.¹⁸ Second, Kant denies that aesthetic judgment can be identified with the cognition of perfection, even once we have construed cognition along transcendental idealist lines. As he declares in the *Critique of Judgment*,

[t]o grasp a regular, purposive structure [*Gebäude*] with one's faculty of cognition (whether the manner of representation be distinct or confused) is something entirely different from being conscious of this representation with the sensation of satisfaction.¹⁹

Aesthetic judgments differ from ordinary cognition, Kant argues, since they relate the representation of an object to the subject's capacity of feeling. As he puts it, through aesthetic judgments the subject "feels itself as it is affected by the representation."²⁰ Of course, on Kant's account, not any feeling of pleasure gives rise to aesthetic experience. A judgment is properly aesthetic only if the subject has reason to claim that others ought to feel the same. She makes a genuine aesthetic judgment only if she can impute the legitimacy of her feeling to everyone else.

In the third *Critique*, Kant proposes to account for the peculiar nature of aesthetic judgments and their difference from ordinary cognition by his theory of the free play of the

faculties. What is important about the intellectual activity involved in judgments of the beautiful, he argues, is that it conforms to the general conditions of cognitive judgment without in fact constituting determinate cognition. Successful cognition depends on the work of the imagination, the capacity to combine the sensory manifold and to be aware of the resulting combination as a unity. It furthermore relies on the faculty of understanding, the conceptual capacity by means of which we make sense of the combined manifold as a unity of a specific sort. Cognition consists in determinate judgments about sensory objects.²¹

Aesthetic judgments significantly differ from determinate cognition thus construed. They are not constituted by the recognition that the object has such and such properties, but by a non-determining reflection in which we are aware of the object as suitable for understanding without, however, construing it as suitable to be understood in any one particular way.²² By reflecting on the imaginative synthesis in a manner that could in principle be brought under concepts, the judgment conforms with the general conditions of cognition while remaining conceptually indeterminate.²³ It is this harmonious yet conceptually indeterminate interaction of imagination and understanding and the associated awareness of the object as fitting with our cognitive capacities that grounds aesthetic pleasure.

Kant characterizes the suitedness of the object for our intellectual faculties as a “purposiveness without a purpose,” that is, a purposiveness whose purpose is conceptually indeterminate.²⁴ The objects of aesthetic appreciation are purposive, on Kant’s account, not because they are conducive to realizing the subject’s particular end, for instance, that of finding the solution to an intellectual problem. Instead, beautiful objects are purposive since, by reflecting on the form of such objects, our cognitive faculties are “unintentionally brought into accord with one another.”²⁵ More specifically, since we do not become conscious of this fit by

subsuming the object under determinate concepts, but through a feeling of pleasure, aesthetic judgment has a distinctive subjective character. Moreover, since this pleasure is related to a harmony of capacities common to all, and not dependent on the satisfaction of any particular idiosyncratic desires, aesthetic pleasure can be imputed to all. This is why Kant maintains that the free play of imagination and understanding is associated with a feeling that has universal validity.

By contrast with Baumgarten's and Meier's aesthetics, on Kant's account, the experience of beauty is thus importantly unlike determinate cognition of the objective structures of reality. Kant draws an important conclusion from this. "There is neither a science of the beautiful, only a critique, nor beautiful science, only beautiful art," he maintains.²⁶ The first half of this assertion follows directly from Kant's account of aesthetic judgment. There can be no science of the beautiful, since there are no rules to specify the features that make something beautiful, neither rules pertaining to the perfection of the object itself nor to its representation.²⁷ Aesthetics therefore cannot be a science but only a critique. It can investigate the cognitive faculties involved in aesthetic judgments, but not the features of an object that constitute its beauty.

Moreover, Kant repudiates not only the conception of aesthetics as a science of beauty but also the possibility of a beautiful science. He claims that "if one were to ask in [such a science] for reasons and proofs one would be brushed aside with tasteful expressions (*Bonmots*)."²⁸ He suggests, in other words, that if there were a beautiful science, scientists would answer the quest for truth by an appeal to beauty. One might wonder, however, why scientists should not be able to give reasons and proofs that would *also* leave room for the free reflection of aesthetic judgment. Why should it be impossible, as Kant seems to suggest, to answer the quest for truth in a way that has aesthetic merit?

In response one might suggest that for Kant a beautiful science is an “*Unding*”—an absurdity, or literally a non-entity—since something can be an object of aesthetic appreciation only if it is sensory.²⁹ According to this suggestion, Kant’s position entails that the purely reflective judgment which grounds the experience of beauty can have as its object only sensory manifolds but no conceptual claims. On this proposal, the synthesizing activity of the imagination would have to be directed at the bare sensory material, not at concepts, judgments or ideas. One might think, furthermore, that abstracting from all concepts in the case of theories or proofs would leave no manifold to be reflected upon, and would thus eradicate all possible candidates for aesthetic appreciation.

A difficulty with this response, however, is that Kant is more than happy to promote other entities as key examples of beauty that, just like scientific theories, deal with concepts and ideas. Such entities include works of poetry and literature; and, indeed, he regards poetry as the highest form of beautiful art.³⁰ Kant can claim as much because he makes room for a second, related, conception of beauty according to which aesthetic judgments consist in reflections on particular representations of concepts and ideas. Aesthetic judgments about poetry and literature, for example, rely on the free and harmonious interaction of the faculties. They do so, however, in engaging not with the bare sensory manifold but with conceptual representations. In contemplating poetry or literature, the imagination is thus free to reflect on an inexhaustible wealth of thoughts associated with the concepts and ideas expressed by the artwork, while being unconstrained by any particular conceptual interpretation.³¹

Goethe’s *Erlkönig*, for example, takes the form of a ballad that conveys the simple story of a father riding home with his sick son who hallucinates being assailed by the ‘erl-king’. The poem tells a simple story whose representation procures imaginative associations of supernatural

powers, of fear and vulnerability, and of abuse and rape. On Kant's account, representations such as these make possible an inexhaustible wealth of thoughts that is not fully determined by the concepts underlying the story itself but nevertheless adequate as an expression of these concepts.³² As Kant puts it, artworks "expand... the mind by setting the imagination free" and by connecting the representation of a concept with "a fullness of thought to which no linguistic expression is fully adequate."³³

Works of art can thus represent concepts while allowing for conceptually unconstrained and inexhaustible reflection. They can do so, Kant claims, because they are the product of genius, the original and exemplary capacity to create artistic expressions that go beyond the content of the concepts they represent, while nevertheless being adequate as expression of those concepts. As Kant puts it,

genius really consists in the happy relation, which no science can teach and no diligence learn, of finding ideas for a given concept on the one hand and on the other hitting upon the *expression* for these, through which the subjective disposition of the mind that is thereby produced, as an accompaniment of a concept, can be communicated to others.³⁴

It is the representations of this original and exemplary capacity that, despite being the product of intention, leave room for judgments in which the harmony of our cognitive faculties can be appreciated, in Kant's earlier words, as "unintentional."³⁵ The expressions of concepts and judgments brought about by the capacity of genius leave room for the free play of the faculties and, hence, for aesthetic pleasure. Kant thus accounts for judgments of beauty that involve

reflection on conceptual representations. Why, then, does he nevertheless maintain that there can be no beautiful science? And why does he add the further claim that genius is possible only in art but not “in the scientific sphere”?³⁶

4. Scientific representations and aesthetic perfection

In order to understand why Kant proclaims that there can be no beautiful science, we must be clear about what the statement entails. I believe Kant’s claim is much more limited than is commonly understood. Kant’s statement is focused on science “as such,” that is, science in the strict sense as a “system of cognition,” consisting in systematically unified determinate judgments.³⁷ There is no indication that Kant is concerned with the scientific enterprise more widely construed, encompassing not only scientific claims such as theories and explanations but also scientific practices such as calculating and experimenting, modeling, representing and visualizing of data and, more broadly, theorizing. This suggests that, when Kant maintains there can be no beautiful science, he makes the narrow claim that determinate cognitions cannot ground aesthetic pleasure. He does not thereby imply that aesthetic judgment has no place in our scientific endeavors more widely conceived.

In accordance with this narrow reading, Kant’s rejection of beautiful science follows straightforwardly from his repudiation of the other rationalist conviction, the principle that aesthetic judgment is a form of determinate cognition. Since determinate judgments cannot ground aesthetic pleasure, on Kant’s account, and since science in the strict sense consists in a system of determinate cognitions, science itself cannot ground aesthetic pleasure. Kant’s

contentious assertion that there is no beautiful science is thus a simple reformulation of his widely acknowledged view that aesthetic judgments are distinct from ordinary cognition. Once Kant's rejection of beauty in science is interpreted in this strict sense, moreover, we can refocus the questions I raised in the previous section. Even if the determinate cognitions of science do not themselves ground aesthetic pleasure, could aesthetic judgments not be a part of science more widely construed as a human activity? Could we not find beauty, for example, in a science that includes the representations and practices of scientists?

Kant addresses the aesthetic dimension of cognition in his lectures on logic and anthropology. He is concerned there with Baumgarten's and Meier's distinction between the aesthetic and logical perfections of cognition. Since Kant's logic lectures are oriented along Meier's logic textbook, *Auszüge aus der Vernunftlehre*, it is not surprising that Kant discusses Meier's distinction there.³⁸ What is more surprising is that, having rejected the rationalist claim that cognitive judgments can ground aesthetic pleasure, Kant holds on to the rationalist distinction and claims that the representations of cognition can be more or less aesthetically valuable.

In the lectures, Kant associates the distinction between the aesthetic and the logical perfection of cognition with that between sensibility and understanding, and their representations, intuitions and concepts. One might therefore think that, for Kant, the aesthetic perfection of cognition has nothing to do with beauty but, following the terminology of the Transcendental Aesthetic of the *Critique of Pure Reason*, with sensory representation in general. On this reading, cognition can be perfected either with the aim of illustrating our concepts through sensory representations (*versinnlichen*), that is, in accordance with the first *Critique* notion of aesthetics (henceforth, 'aesthetics_{C1}'), or with the aim of gaining conceptual insight,

that is logically.³⁹ While logical perfection aims at the complete clarification of concepts and conceptual relations, the goal of aesthetic_{C1} perfection is “comprehensibility” (*Faßlichkeit*), that is, the capacity of the significance of concepts to be grasped in concrete cases.⁴⁰ Aesthetic_{C1} perfection is achieved, for instance, through the use of examples and illustrations as in the work of Fontenelle.⁴¹ It concerns the “ease” and “liveliness” with which cognition is attained.⁴²

Construed in this way, maintaining Baumgarten’s and Meier’s distinction between two types of perfection is unproblematic for Kant, since it does not concern his conception of beauty at all. By contrast with the rationalists, Kant holds that cognition requires connection with sensibility, just as it requires conceptual recognition of the sensible. Kant can thus coherently hold that both types of representation, intuitive and conceptual, or aesthetic_{C1} and logical, are necessary for cognition. On this reading, what Kant spells out by elaborating on the aesthetic_{C1} perfection of cognition, are the empirical conditions of how sensible representation is achieved for creatures like us.⁴³ Both logical and aesthetic_{C1} perfections can be regarded as perfections some instantiation of which is necessary for cognition.

And yet this is not the end of the story. For, in other parts of the lectures, Kant qualifies his conception of aesthetic_{C1} perfection along the lines of his theory of beauty, and thus moves on to the third *Critique* notion of aesthetics (henceforth, in this section, ‘aesthetics_{C3}’). He suggests that we “can think of an aesthetic perfection that contains the ground of a subjectively universal pleasure” where, as he puts it bluntly, “this is *beauty*.”⁴⁴ What Kant calls ‘aesthetic perfection of cognition’ is thus concerned not only with the way in which a claim is presented to the senses, i.e. aesthetically_{C1}, but also with whether it is presented in a way that is universally pleasing, i.e. aesthetically_{C3}. More specifically, Kant seems to think of the two notions as closely connected and, in particular, of the third *Critique* notion as dependent on the first. Strictly speaking, Kant

claims, judgments of beauty are not about cognition as such but about its sensory expression. As he puts it, “there is really no beautiful cognition..., but only the *exhibition* [of cognition] can be *beautiful*.”⁴⁵ ‘Aesthetic perfection of cognition’ is thus concerned, not with the aesthetic_{C3} features of abstract propositions that form part of an inferential structure, but with the aesthetics_{C3} of their sensory expression.

Aesthetic_{C3} reflection can thus be directed at determinate judgments, on Kant’s account, if these judgments are given the right sensible representation. And, as we know from the *Critique of Judgment*, the right sensible representation is one that leaves room for the free play of the faculties, a representation that suitably expresses the judgment represented, while giving the imagination free reign to run through an indeterminate plethora of associated thoughts. Moreover, as we also know from the third *Critique*, aesthetic_{C3} representations that involve concepts and ideas are the product of the original and exemplary capacity Kant calls “genius.” It is this capacity which can produce representations that are suitable for expressing the relevant concepts or ideas, without being wholly determined by those concepts or ideas. It is this capacity, too, which therefore allows us to represent logically distinct cognition in ways that are aesthetically_{C3} pleasing. This is how we can understand Kant’s suggestion in the lectures that it is the capacity of genius to bring about the combination of aesthetic_{C3} with logical perfection:

It is in the greatest possible unification of logical with aesthetic perfection in general, in respect to those cognitions that are both to instruct and to entertain, that the character and the art of genius actually shows itself.⁴⁶

Represented in the right way, a determinate judgment of cognition may thus be appreciated aesthetically_{C3} just as it can be understood conceptually. I argue that there is no reason, on Kant's account, to limit such representations to fine art, or to exclude representations of scientific cognition. Goethe's *Erlkönig* may lead us to understand the conception of vulnerability and violence expressed by the poem, while inspiring us to associations about nature's power over man, or the weight of parental responsibility. In the same way, I suggest, a representation of the evolutionary lineage of finch species may lead us to grasp Darwin's theory of evolution, while inspiring us to think through implications of the theory we had not previously considered, or draw connections with other natural phenomena we had not previously seen. In both examples, there is room for the free play of the faculties. In both art and science, Kant's theory can thus account for aesthetic_{C3} pleasure as grounded in the awareness of an indeterminate fit of the object of appreciation with our intellectual capacities.

One may object against my proposal that there is an important disanalogy between art and science. One may argue that Kant's transcendental and metaphysical principles, developed in the *Critique of Pure Reason* and the *Metaphysical Foundations of Natural Science*, ensure that our scientific concepts have determinate application to the phenomena, and hence that any representation of those concepts would leave no room for free play. Scientific concepts denote natural kinds or empirical laws that govern natural processes. They can be defined in terms of more familiar concepts, explicated in relation to other theoretical principles, and illustrated by means of examples. Art, by contrast, is usually concerned with moral, political or theological ideas, and hence with indeterminate ideas that transcend experience.⁴⁷ In order to give sensible expression to these super-sensible concepts, they must be represented indirectly and by means of symbols.⁴⁸ It is because of this disanalogy, one might therefore argue, that art requires indirect,

symbolic representations, which “occasion... much thinking,” while the concepts and principles of science stand in a determinate relation to natural phenomena and can be illustrated directly and without the use of symbols.⁴⁹ Newton’s gravitational law, for example, can be illustrated by its application to particular cases. But, according to the present objection, such illustration would leave no room for the free play of the faculties, nor therefore for aesthetic_{C3} appreciation.

In response to this objection it is important to note, however, that on Kant’s account expressing the relation between scientific ideas and the objects they represent is more complex than the above contrast between art and science may lead one to assume. According to Kant, science is not simply in the business of describing states of affairs but of formulating universal principles and discovering necessary laws whose universal and necessary status is not easily exemplified by individual empirical cases. Most importantly, science aims at a unified conception of reality, ordered according to a system of concepts and principles. I argue that it is because the systematic unity of all cognitions is a necessary goal of science, for Kant, that scientific representations may demand the imagination to go beyond what is directly expressed by sensory particulars and thus allow for aesthetic_{C3} reflection.⁵⁰

Let me spell out this suggestion in some more detail. Kant holds that we cannot cognize the world as a determinate and fully unified whole. This cognitive limitation notwithstanding, he also argues that we are necessarily guided by the indeterminate idea of unity in all our scientific investigations. More specifically, in science we must presuppose that all cognition of local phenomena is always part of a larger whole and that it can be systematically related to other parts within that whole.⁵¹ Moreover, we have to assume that the objects of those cognitions are such that they can be cognized in this way, and that particular phenomena are systematically related

and governed by universal laws.⁵² The idea of unity thus guides scientific enquiry and informs scientific cognition.

As a concept of reason, however, the idea of unity cannot be represented directly in sensibility. Its sensory representation requires the original and exemplary employment of our imaginative and conceptual faculties. In order to sensibly represent the conception of unity that scientific cognition presupposes we therefore need to use indirect, symbolic representations. We have to employ a particular that stands in for the unified whole, and that expresses more than is strictly determined by what we have cognized.⁵³ I argue that it is representations of this kind that require the original and exemplary activity of genius and can be the object of aesthetic_{C3} appreciation. Scientific representations are thus beautiful, on this conception, when they succeed in expressing a scientific concept or principle while also giving us a glimpse of the unity of nature at which our science aims.

Kant does not give examples, let alone scientific ones, in his lectures (and one may bemoan that his writing falls foul of his own standards of aesthetic_{C3} perfection). If my suggestion is right, however, his account allows for such cases of science in the arts as Fontenelle's popular writings. Moreover, and more importantly, examples may also include the work of scientists themselves such as geometrical diagrams, physical models, chemical experiments, or biological exemplars that represent in an instance the universal conception implied by the theory. Louis Pasteur's separation of mirror-image molecular forms of tartaric acid, for example, is often regarded as one of the most beautiful experiments in the history of chemistry.⁵⁴ Pasteur's conceptually simple experiment shows, in a carefully executed way, that chiral molecules—molecules with a right- or left-handed orientation—are optically active. They rotate polarized light, unless there are mirror-image molecular groupings in the mix which cancel the effect.

Pasteur's experiment reveals clearly and unambiguously this important truth in chemistry. The beauty of the experiment lies in its capacity to show in one glimpse a universal chemical principle, underlying a whole range of phenomena. At the same time, it leaves indefinite room for the imagination to contemplate the implications of this principle and to run through an inexhaustible string of associated representations. It expresses a universal idea by stimulating thought beyond the particular case represented and by procuring images of the whole of nature for which the principle holds.⁵⁵ On the Kantian account I suggest, we can appreciate Pasteur's experiment as beautiful because it presents a scientific idea in a way that leaves room for the free play of the faculties.

On the Kantian conception, I argue, representations of scientific concepts and principles can thus be the object of aesthetic_{C3} appreciation. As the example of Pasteur's experiment shows, moreover, this account makes good sense of some actual instances of aesthetic_{C3} judgments in science. To be clear, Kant does not spell out this conception of the aesthetics_{C3} of scientific representations explicitly. But, as I have argued in this section, his theory provides the necessary resources for it. Once we recognize that Kant's express rejection of the beauty of science has limited scope, we can thus see that, on his account, representations of scientific insights can be the object of aesthetic_{C3} appreciation.

5. Scientific theories and reflective judgment

The previous section shows that the Kantian conception can account for the aesthetics of sensible representations in science. One may worry, however, that sensible representations are only a

marginal part of the enterprise of science. They may be important in formulating, testing, communicating and understanding scientific claims. But they are neither the only nor the central aspect commonly associated with the aesthetic dimension of science. We may, for example, find beauty in Einstein's explanations of the large-scale structure of the universe entirely independently of any particular representation. From the foregoing discussion it is unclear how to account for such a case. Does Kant's rejection of the science of beauty commit him, after all, to significantly restricting the scope of the beauty of science, even if he does not rule it out entirely?

A positive answer to this question would, I think, be mistaken. For, if we follow the argument of the last section through, we see that the results present a particular instance of a more general Kantian insight. This is the recognition that it is not science in the strict sense, but the scientific enterprise broadly construed, that can be the object of aesthetic appreciation. I thus suggest that the insight of the previous section holds not only for sensible representations but also for scientific theories and explanations broadly conceived as the product of spontaneous, creative activity.

Once again, this suggestion may be received with scepticism. For, once again, science may seem unsuitably determinate to allow for the free reflection that grounds aesthetic appreciation. What, one might ask, is more crucial to Kant's defense of the objectivity of science than his claim that our knowledge of nature is conceptually guided and grounded in the fundamental a priori principles of the understanding? As we know from the first *Critique* and the *Metaphysical Foundations*, the transcendental and metaphysical laws of nature govern the formulation of particular scientific concepts and principles. Theorizing about the phenomena is essentially structured by a priori rules and importantly different from the free reflection associated with

artistic processes. In support of this objection, one might further point to Kant's famous—or, perhaps, infamous—claims about Newton. Newton may have been a great thinker, Kant maintains, but his work lacked the originality of real genius that can only be found in art:

Everything that Newton expounded in his immortal work on the principles of natural philosophy, no matter how great a mind it took to invent it, can still be learned; but one cannot learn to write inspired poetry, however exhaustive all the rules for the art of poetry and however excellent the models for it may be.⁵⁶

On Kant's account, the principles of natural philosophy can be taught and learnt. According to the objection, scientific cognition is therefore essentially conceptually determined and, hence, leaves no room for the free reflection required for judgments of beauty.

In response to this challenge, however, it is important to read Kant's bold assertions about Newton with care. Kant contrasts rules for writing inspired poetry with the principles of natural philosophy, and he argues that while the first are unavailable, the second can be taught and learnt. To be precise, Kant opposes rules for writing poetry with scientific principles themselves and not with the rules for doing science or formulating theories. As before, Kant's explicit focus is on the fundamental difference between the determinate judgments of science, strictly construed as a system of cognitions, and the indeterminate reflective judgments of aesthetics. But this contrast, by itself, does not rule out the possibility that creative and original reflection plays a role in scientific practice and, hence, that there is beauty in science in the broad sense. The implications of Kant's critical claims about the genius of Newton may thus be more limited than is commonly thought.

To begin seeing this, it is important to recognize the diversity of scientific practice. Much of science follows entirely mechanical procedures. Data gathering, hypothesis testing, and the fine-tuning of experiments in response to experimental results are carried out according to more or less standard routines. And yet it is far from obvious that we can spell out determinate rules for all aspects of scientific practice including, in particular, the formulation of new scientific concepts and principles. By contrast, scientific ideas seem often to be discovered in unobvious and roundabout ways. Their discovery may involve visual aids, analogical thinking, and more creative sources of inspiration. Some original and exemplary thought processes are needed in order to develop ideas that promise new solutions to scientific problems.

Kant incorporates this thought in his account of reflective judgment. He argues that the a priori determination of cognition by means of the constitutive principles of the understanding is not by itself sufficient for scientific research. The transcendental and metaphysical laws of the first *Critique* and the *Metaphysical Foundations* determine the fundamental structure of nature as such, but they leave under-determined the specific character of particular natural phenomena and the specific empirical instantiation of the universal laws that govern those phenomena. As Kant puts it in the introduction to the *Critique of Judgment*, even according to the a priori “universal laws, without which the form of an experiential cognition in general would not obtain at all,” natural phenomena may still remain incomprehensible to us. They could appear so diverse that it would be impossible for us “to make an interconnected experience out of material that is for us so confused.”⁵⁷ Scientific understanding of particular natural phenomena is not guaranteed, Kant argues, by a simple application of the a priori laws to empirical data.

The activities of science thus rely on a further capacity in addition to that of determining judgment. Scientific practice requires the work of reflecting judgment, the ability to search for

unity among the manifold of particular cognitions.⁵⁸ Kant recognizes that this capacity consists in comparing and contrasting particular phenomena, following methods of induction and analogy, and that such empirical research is guided by the regulative principle “that what is contingent for human insight in the particular (empirical) laws of nature nevertheless contains a lawful unity.”⁵⁹ Scientific reflection thus presupposes the idea that the empirical data presented to us can be understood according to unifying concepts and principles whose content is yet to be determined. It relies on the guiding idea that the empirical given is suitable, in an as yet undetermined way, to our unifying ambitions.

It follows, on Kant’s account, that scientific discoveries are not the result of a completely explicable mechanism, even if the concepts and principles thereby discovered can be fully spelt out. Although scientific theorizing aims at concepts and principles that are empirically adequate and, ultimately, provide a true account of the phenomena, it does so by reflecting on how the phenomena form part of a systematic unity of nature as a whole. It requires reflecting on an idea of reason that goes beyond any scientific concepts and principles strictly construed. It thus consists in imaginatively engaging with how this idea may be expressed in, and partially instantiated by, the narrowly scientific concepts and principles that determine the phenomena. I argue, moreover, that this reflective and imaginative capacity is continuous with the original and exemplary ability with which we are familiar from Kant’s discussion of art. It consists in searching for conceptual representations that are not fully determined by the principles and ideas already available, and yet nevertheless give adequate expression to these principles and ideas. Scientific theories and explanations thus construed result from the attempt of finding instantiations of the universal laws of the understanding that give a partial, and as yet indeterminate, representation of the idea of systematic unity. It is this aspect of scientific

reasoning, I suggest, which accounts for its continuity with the reflective activity involved in the creation of art and which may therefore be called an activity of ‘genius’.⁶⁰

On the Kantian account, the formulation of a particular scientific theory or explanation, just as the sensible representation of scientific ideas considered in the previous section, thus relies on a free and creative intellectual activity. Scientific theories and explanations that are the result of this creative activity can, moreover, leave room for the unconstrained reflection that grounds aesthetic pleasure. Theories and explanations may prompt us to run through unobserved implication, think about instantiations under novel conditions, and draw out as yet undiscovered connections with other parts of science. They may thereby leave indefinite room to contemplate a wealth of representations, suitably associated with the idea of the unity of nature. I argue that it is this free and imaginative reflection, afforded by theories that are the result of a creative intellectual process, that makes possible the free play of the faculties and thereby grounds aesthetic pleasure.

Kant does not offer any examples of the aesthetic appreciation of theories and explanations. But we may conceive of it as the pleasure, sometimes described by scientists, of seeing the connection between things, of experiencing the parts fall into place, and of having the whole world in view.⁶¹ We may associate it with the aesthetic experience, in contemplating a theory, of getting a glimpse of that which lies beyond what is strictly determined by the theory, and with the feeling that our minds are in harmony with the world as a whole. It is this experience of being in tune with the world around us, I believe, that is captured by the Kantian account.

Once again, Kant does not make this account of the aesthetics of theories and explanations explicit. And, in his statements about Newton, he even seems to proclaim views to the contrary

when he maintains that “[i]n the scientific sphere... the greatest discoverer differs only in degree from the most hardworking imitator and apprentice.”⁶² As I have suggested in this section, however, the denial of scientific genius does not sit well with the implications of Kant’s own aesthetic theory. Moreover, Kant comes close to endorsing these implications when he argues in the *Critique of Judgment* that the successful unification of diverse phenomena is recognized with a feeling of pleasure, while disunity is experienced as displeasing. As he puts it,

the discovered unifiability of two or more empirically heterogeneous laws of nature under a principle that comprehends them both is the ground of a very noticeable pleasure, often indeed of admiration, even of one which does not cease though one is already sufficiently familiar with its object.⁶³

On the reading I have suggested, what is considered as pleasing are not any particular properties of the scientific principle. What elicits in us a sense of pleasure, or admiration, is rather the awareness of fit, grounded in the free reflection on the principle that provides us with unified explanations of the phenomena, while leaving room for free reflection on the unity of nature as a whole.

One might object, at this point, that my reading confuses the aesthetic appreciation of science with a form of “intellectual” pleasure.⁶⁴ In support of this objection, one could point to Kant’s further claim that our pleasure in “the comprehensibility of nature and the unity of its division into genera and species” fades over time.⁶⁵ One might thus argue that the pleasure associated with unification does not last, because it is connected with the satisfaction of our desire to increase understanding, and therefore subsides once this desire has been met. The

pleasure we experience in the unification of scientific principles would thus differ from the “enduring” character of aesthetic pleasure.⁶⁶

In response it is fair to acknowledge that Kant does not use the term ‘aesthetic’ in this context. Nevertheless there is no reason to rule out the possibility of genuine aesthetic pleasure. As Kant puts it, we may no longer “notice” the pleasure associated with the unification of empirical laws “only because... it [has] gradually become mixed up with mere cognition.”⁶⁷ In other words, in the case of principles or theories that we employ in much of ordinary reasoning, we may no longer be “attentive” to the kind of free reflection that these principles or theories afford, but only focus on the determinate judgments they strictly entail. We may pay attention only to their content narrowly construed, as we do, for example, in making predictions or testing hypotheses.⁶⁸ However, such—admittedly important—focus on the determinate content of scientific claims does not exclude the possibility of also aesthetically appreciating principles and theories broadly construed as the product of a creative intellectual process. Considering the empirical adequacy and truth of a theory no more rules out the possibility of also making aesthetic judgments about the theory, than studying a play as an historical source detracts from its aesthetic value.

I suggest that we can thus find in Kant the resources for a general conception of the aesthetics of science of which the more limited account of the aesthetic perfection of cognition, discussed in the previous section, presents one particular instance. On this account, scientific representations as well as theories—including Einstein’s theory of general relativity—are beautiful, if they are the product of a free and creative reflective activity associated with the capacity of genius. Just as beautiful representations, scientific theories can be considered as indeterminately expressing an idea that goes beyond the determinate concepts and principles they

strictly entail. They leave room for the free play of the faculties, and for a special aesthetic appreciation of beauty in science. Kant's famous claim against the ingenuity of Newton should therefore not be read as Kant's only—or even, perhaps, most important—word about the possibility of a beautiful science. It is more plausibly taken as a call for caution against those who mistake determinate cognition with the reflective judgments that ground aesthetic pleasure.⁶⁹ Kant's negative claims about Newton thus stand alongside the more significant insight that science in the broad sense, as a creative and intellectual endeavor, can be the object of an indeterminate and inexhaustible reflection that grounds aesthetic pleasure.

6. Conclusion

On the Kantian account I have proposed in this paper, the science of beauty and the beauty of science do not stand or fall together. We can hold on to the latter while letting go of the former. Kant's philosophy thus offers the resources for a positive alternative to the Platonic ideal that is expressed and developed by such rationalist philosophers as Baumgarten and Meier. On the account we can construct from these Kantian resources, science can be aesthetically pleasing, not because the claims of science have determinately specifiable aesthetic features, but because the claims and representations of science leave room for the free use of the imagination in reflecting on the inexhaustible richness associated with the systematic unity of nature. On this Kantian conception, there are no aesthetic principles to form part of a science of beauty, but there can be genuine aesthetic appreciation of the claims and representations of science.

This Kantian conception may not account for all aesthetic judgments ever made or ever to be made about science. Scientists and science students may use aesthetic statements in a host of different ways. Nor does the Kantian conception answer all questions about scientific beauty. For example, it remains quiet, so far, about the heuristic role aesthetic judgments may play in science.⁷⁰ Despite these limitations, however, the account I have proposed captures an important dimension of the aesthetics of science. It thereby shows that Kantian aesthetics does not support skepticism about scientific beauty. Furthermore, there are even grounds for thinking that the Kantian conception may turn out specifically suited to accounting for the role of aesthetics in the search for truth. The conception of scientific beauty I have proposed is directly linked to Kant's theory of cognition. It is tied up with his claim that cognition requires sensibility as much as it requires understanding. And it is intimately connected with his conception of science as essentially incomplete and open-ended.⁷¹ I believe it is an important implication of this close link that, on the Kantian account, the aesthetics of science plays a central role in our cognitive endeavors. While I cannot give a definitive defense of this further claim here, I shall end by pointing out a surprising disanalogy between my Kantian proposal and the rationalist position that is relevant to such a defense.

As we have seen, for Baumgarten and Meier, aesthetic judgments are a particular species of cognition, offering sensible access to scientific truths. On this conception, aesthetically perfected cognition can provide a first approximation to, and perhaps a way of raising interest in, the more abstract rational insights of science. However, on their account, the aesthetic perfection of cognition pulls in the opposite direction from its logical perfection, since aesthetic judgments do not themselves contribute to the type of clarity demanded of scientific cognition. Baumgarten and Meier may promise a more intimate relationship between science and beauty. They argue,

for example, that the “most perfect” cognition is achieved only by a “beautiful spirit” who, like Fontenelle, manages to realize the combined goals of sensible and rational cognition.⁷² But this highest perfection can be no more than a compromise. Beautiful cognition may satisfy a need of our passions, but this need is only peripheral to the search for truth.

On the Kantian account, by contrast, aesthetic judgments offer no alternative access to scientific truth. Far from contrasting with the requirements of cognition, the intellectual activities that make possible aesthetic pleasure are central to the scientific enterprise itself. They lie at the heart of the activities involved in discovering, understanding, and presenting scientific insights. On the Kantian account, the experience of beauty in science provides no direct link to truth. But it may thus offer a sensible sign of the intellectual processes required for the search for truth.⁷³

Bibliography and Abbreviations

- Allison, Henry. *Kant's Theory of Taste*. Cambridge: Cambridge University Press, 2001.
- Ameriks, Karl. "Kant and the Objectivity of Taste." *British Journal of Aesthetics* 23 (1983): 3–17.
- Ameriks, Karl. *Interpreting Kant's Critiques*. Oxford: Oxford University Press, 2003.
- Ball, Philip. *Elegant Solutions: Ten Beautiful Experiments in Chemistry*. Royal Society of Chemistry, 2005.
- Bangu, Sorin. "Pythagorean Heuristic in Physics." *Perspectives on Science* 14 (2007): 387–416.
- Baumgarten, Alexander Gottlieb. "Handschrift." In *Alexander Gottlieb Baumgarten: Seine Bedeutung und Stellung in der Leibniz-Wolffischen Philosophie und seine Beziehung zu Kant*, edited by Bernhard Poppe, 65–258. Leipzig: Noske, 1907. [Med.]
- Baumgarten, Alexander Gottlieb. *Reflections on Poetry: Alexander Gottlieb Baumgarten's Meditationes philosophicae de nonnullis ad poema pertinentibus*. Translated by Karl Aschenbrenner and William B. Holten. Berkeley: University of California Press, 1954.
- Baumgarten, Alexander Gottlieb. *Aesthetica/Ästhetik*. Translated by Dagmar Mirbach. Hamburg: Meiner, 2007. Vols. I–II. [Aesth.]
- Baumgarten, Alexander Gottlieb. *Metaphysics*. Translated by Courtney D. Fugate and John Hymers. London: Bloomsbury, 2013. [Met.]
- Beardsley, Monroe. *Aesthetics: Problems in the Philosophy of Criticism*. Indianapolis: Hacker, 1981.
- Beiser, Frederick. *Diotima's Children*. Oxford: Oxford University Press, 2009.

- Binkley, Timothy. "Piece: Contra Aesthetics." *Journal of Aesthetics and Art Criticism* 35 (1970): 265–277.
- Breitenbach, Angela. "Aesthetics in Science: A Kantian Proposal." *Proceedings of the Aristotelian Society* 113 (2013): 83-100.
- Breitenbach, Angela. "Beauty in Proofs: Kant on Aesthetics in Mathematics." *European Journal of Philosophy* 23 (2015): 955–977.
- Chandrasekhar, S. *Truth and Beauty: Aesthetics and Motivations in Science*. Chicago: Chicago University Press, 1987.
- Chignell, Andrew. "Kant on the Normativity of Taste: The Role of Aesthetic Ideas." *Australasian Journal of Philosophy* 85 (2007): 415–433.
- Cohen, Alix. "Kant on Beauty in Science: The Aesthetic Dimension of Cognition." (MS)
- Costello, Diarmuid. "Kant and the Problem of Strong Non-Perceptual Art." *British Journal of Aesthetics* 53 (2013): 277–298.
- Descartes, René. *The World and Other Writings*. Translated by Stephen Gaukroger. Cambridge: Cambridge University Press, 1998.
- Duhem, Pierre. *Aim and Structure of Physical Theory*. Princeton, NJ: Princeton University Press, 1954.
- Fontenelle, Bernard. *The Plurality of Worlds*. Translated by John Glanvill. London: Osbourne, 1702.
- Förster, Eckart. *Die 25 Jahre der Philosophie*. Frankfurt: Vittorio Klostermann, 2011.
- Gerard, Alexander. *An Essay on Genius*. London: W. Strahan, 1774.
- Ginsborg, Hannah. *The Role of Taste in Kant's Theory of Cognition*. New York: Garland Publishing, 1990.

- Ginsborg, Hannah. *The Normativity of Nature: Essays on Kant's Critique of Judgment*. Oxford: Oxford University Press, 2015.
- Giordanetti, Piero. "Das Verhältnis von Genie, Künstler und Wissenschaftler in der Kantischen Philosophie: Entwicklungsgeschichtliche Betrachtungen." *Kant-Studien* 86 (1995): 406–30.
- Gregor, Mary. "Baumgarten's 'Aesthetica.'" *The Review of Metaphysics* 37 (1983): 357–385.
- Guyer, Paul. *Kant and the Experience of Freedom*. Cambridge: Cambridge University Press, 1993.
- Guyer, Paul. *Kant and the Claims of Taste*. Cambridge: Cambridge University Press, 1997.
- Guyer, Paul. "Gerard and Kant: Influence and Opposition." *Journal of Scottish Philosophy* 9 (2011): 59–93.
- Guyer, Paul. *History of Modern Aesthetics*. Cambridge: Cambridge University Press, 2014. Vols. I–III.
- Heisenberg, Werner. "The Meaning of Beauty in the Exact Sciences." In his *Across the Frontiers*. Translated by Peter Heath. New York: Harper & Row, 1974.
- Jankowiak, Timothy and Eric Watkins. "Meat on the Bones: Kant's Account of Cognition in Anthropology Lectures." In *Kant's Anthropology Lectures: A Critical Guide*, edited by Alix Cohen, 57–75. Cambridge: Cambridge University Press, 2014.
- Kant, Immanuel. *Kants Werke*. Berlin: Preußische Akademie der Wissenschaften, 1900 ff.
- Kant, Immanuel. *Lectures on Logic*. Translated by J. Michael Young. Cambridge: Cambridge University Press, 1992.
- Kant, Immanuel. *Practical Philosophy*. Translated by Mary Gregor. Cambridge: Cambridge University Press, 1996.

- Kant, Immanuel. *Critique of Pure Reason*. Translated by Paul Guyer and Allen Wood.
Cambridge: Cambridge University Press, 1999. [CPR]
- Kant, Immanuel. *Critique of the Power of Judgment*. Translated Paul Guyer and Eric Matthews.
Cambridge: Cambridge University Press, 2000. [CJ]
- Kant, Immanuel. *Anthropology, History and Education*. Translated by Günter Zöllner and Robert
Louden. Cambridge: Cambridge University Press, 2007.
- Kivy, Peter. "Science and Aesthetic Appreciation." *Midwest Studies in Philosophy* 16 (1991):
180–195.
- Kuhn, Thomas S. "Objectivity, value judgment, and theory choice." In his *Essential Tension*,
320–339. Chicago: Chicago University Press, 1973.
- Kukla, Rebecca, ed. *Aesthetics and Cognition in Kant's Critical Philosophy*. Cambridge:
Cambridge University Press, 2006.
- Leibniz, Gottlieb Wilhelm. *Philosophical Papers and Letters*. Edited by Leroy E. Loemker.
Dordrecht: Reidel, 1969.
- Leibniz, Gottlieb Wilhelm. *Philosophical Essays*. Translated by Roger Ariew and Daniel Garber.
Indiana: Hackett, 1989.
- Lipton, Peter. *Inference to the Best Explanation*. London: Routledge, 2004 (second edition).
- Longuenesse, Béatrice. "Kant's Leading Thread in the Analytic of the Beautiful." In Kukla,
Aesthetics and Cognition in Kant's Critical Philosophy, 194–221.
- Makkreel, Rudolf. "Reflection, Reflective Judgment, and Aesthetic Exemplarity." In Kukla,
Aesthetics and Cognition in Kant's Critical Philosophy, 223–244.
- McAllister, James. *Beauty and Revolution in Science*. Ithaca: Cornell University Press, 1996.
- McAllister, James, ed. *Aesthetics of Science*, special issue, *International Studies in the*

- Philosophy of Science* 16 (2002).
- Meier, Georg Friedrich. *Auszug aus der Vernunftlehre*. Halle, 1752. (Reprinted in: Kant, *Kants Werke*, Vol. XVI). [Vern.]
- Meier, Georg Friedrich. *Frühe Schriften*. Halle: Hallescher Verlag, 1999–2002. Vols. I-III.
- Poincaré, Henri. *Science and Method*. Translated by F. Maitland, London: T. Nelson and Sons, 1908.
- Rueger, Alexander. “Kant and the Aesthetics of Nature.” *British Journal of Aesthetics* 47 (1997): 138–155.
- Shelley, James. “The Problem of Non-Perceptual Art.” *British Journal of Aesthetics* 43 (2003): 363–378.
- Sigman, Jill and Bas van Fraassen. “Interpretation in Science and in the Arts.” In *Realism and Representation*, edited by George Levine, 73–99. Madison: University of Wisconsin Press, 1993.
- Todd, Cain. “Unmasking the Truth Beneath the Beauty.” *International Studies in the Philosophy of Science* 22 (2008): 61–79.
- Wenzel, Christian. “Beauty, Genius, and Mathematics: Why Did Kant Change his Mind?” *History of Philosophy Quarterly* 18 (2001): 415–432.
- Wolff, Christian. *Vernünfftige Gedanken von Gott, der Welt und der Seele des Menschen, auch allen Dingen überhaupt*. Halle, 1719. [German Metaphysics]
- Zammito, John H. *The Genesis of Kant’s Critique of Judgment*. Chicago: University of Chicago Press, 1992.
- Zangwill, Nick. *The Metaphysics of Beauty*. Ithaca: Cornell University Press, 2001.

Zangwill, N. "Beauty." In *Oxford Companion to Aesthetics*, edited by Jerrold Levinson, 325-343.

Oxford: Oxford University Press, 2003.

Zee, A. *Fearful Symmetry*. Princeton: Princeton University Press, 1999.

Zuckert, Rachel. "The Purposiveness of Form: A Reading of Kant's Aesthetic Formalism."

Journal of the History of Philosophy 44 (2006): 599–622.

Zuckert, Rachel. "Kant's Rationalist Aesthetics." *Kant-Studien* 98 (2007a): 443–463.

Zuckert, Rachel. *Kant on Beauty and Biology: An Interpretation of the Critique of Judgment*.

Cambridge: Cambridge University Press, 2007b.

¹ The literature on this controversy in philosophy of science is vast and diverse. See e.g. Duhem, *Aim and Structure of Physical Theory*; Kuhn, "Objectivity, value judgment, and theory choice"; Sigman and van Fraassen, "Interpretation in Science and in the Arts"; McAllister, *Beauty and Revolution in Science and Aesthetics of Science*; Lipton, *Inference to the Best Explanation*; Bangu, "Pythagorean Heuristic in Physics." The literature in aesthetics is less extensive. See e.g. Zangwill, *The Metaphysics of Beauty*; Todd, "Unmasking the Truth Beneath the Beauty"; and the older and less critical discussion in Kivy, "Science and Aesthetic Appreciation."

² Poincaré, *Science and Method*, 24. See also Chandrasekhar, *Truth and Beauty: Aesthetics and Motivations in Science* and Zee, *Fearful Symmetry*.

³ See Zangwill, *The Metaphysics of Beauty* and "Beauty"; also Rueger, "Kant and the Aesthetics of Nature" and Wenzel, "Beauty, Genius, and Mathematics: Why Did Kant Change his Mind?". I have developed a first objection to this view in Breitenbach, "Aesthetics in Science: A Kantian Proposal" and "Beauty in Proofs: Kant on Aesthetics in Mathematics." Similarly, in her "Kant on

Beauty in Science: The Aesthetic Dimension of Cognition”, Cohen argues that science can be beautiful on Kant’s account.

⁴ Baumgarten first introduced the term “aesthetics” in his 1735 *Meditationes philosophicae de nonnullis ad poema pertinentibus* (henceforth *Med.*), translated as *Reflections on Poetry*. He developed related reflections on beauty in his *Metaphysica* (henceforth *Met.*) of 1739.

Baumgarten’s more detailed *Aesthetica* (henceforth *Aesth.*) followed in 1750 (vol. I) and 1758 (vol. II) but remained incomplete by the time of his death in 1762. All references are to

Baumgarten, *Reflections on Poetry: Alexander Gottlieb Baumgarten's Meditationes philosophicae de nonnullis ad poema pertinentibus, Metaphysics, and Aesthetica/Ästhetik*.

Meier’s publications on aesthetics are extensive, including the three-volume *Anfangsgünde aller schönen Wissenschaften* (1748–50) and many shorter writings from the early 1750ies, collected as *Frühe Schriften zur Erziehung der Deutschen* (1999–2002). His *Auszüge aus der Vernunftlehre* (1752, henceforth *Vern.*) set out a summary account of the relation between cognition and aesthetics. For the purposes of this paper, I shall focus only on what Baumgarten and Meier have in common and set aside their differences.

⁵ Kant relies on *Met.* in his metaphysics lectures and on *Vern.* in his logic lectures throughout his career. See section 4 below. All references to Kant are to the volume and page numbers of the Akademie edition (Kant 1900 ff.), except in case of the *Critique of Pure Reason* (henceforth *CPR*), which is cited by reference to the A and B pagination of the original 1781 and 1787 editions. Translations are from Kant, *Lectures on Logic, Practical Philosophy, Critique of Pure Reason* and *Critique of the Power of Judgment*, unless indicated otherwise.

⁶ See *Met.*, §94 and *Vern.*, §22. On Leibniz' conception of beauty as the feeling of perfection, see his "On Wisdom" of c. 1690 in his *Philosophical Papers and Letters*, 425–428. On Wolff's related notion, see his *German Metaphysics*, §404 ff.

⁷ *Met.*, §662.

⁸ See *Med.*, §§13-14 and *Vern.*, §115 and §137. Cf. Leibniz's "Meditations on Knowledge, Truth and Ideas" from 1684 in his *Philosophical Essays*, 23–27, and Wolff, *German Metaphysics*, §277.

⁹ Meier, "Gedanken von dem Werthe der freyen Künste und schönen Wissenschaften in Absicht auf die obern Kräfte der Seele," in his *Frühe Schriften*, vol. I, 62 (my translation). See also *Met.*, §655.

¹⁰ Baumgarten and Meier describe this difference as an increase in "extensive" as opposed to "intensive" clarity. See *Med.*, §16; *Met.*, §531 and §634; *Vern.*, §135.

¹¹ In line with this, Baumgarten presents beauty in his later *Aesthetica* as the perfection of sensible cognition itself, and no longer, as he had done in his earlier *Metaphysica*, as the sensible cognition of perfection. See *Aesth.*, §14. Cf. Meier, "Betrachtungen über den ersten Grundsatz aller schönen Künste und Wissenschaften," in his *Frühe Schriften*, vol. III, 192-3. One might be tempted to regard this later notion as essentially distinct from Baumgarten's earlier conception of beauty, since, according to the later notion, beauty seems to inhere in the representation and not in the cognition of perfection represented. However, the two notions are not independent. Beauty, on the first conception, requires some instantiation of the second. For, whether beauty is primarily grounded in the perfection of the object or in that of its representation, it can only be cognized in the extensively clear but confused manner of the senses. Furthermore, the second

notion of beauty also requires some instantiation of the first. For even aesthetically perfected representation must constitute a form of the objective cognition of perfection in order to count as the perception of beauty. The perfection of our sensory cognition is possible only if it “complies” with the cognition of the object (Baumgarten, “Handschrift,” 90). On either of the two characterizations of beauty, aesthetic judgments thus consist in the objective cognition of perfection, attained through the senses. What the second notion adds is that the same perfection in the object can be sensibly represented more or less perfectly and hence more or less beautifully. For further discussion, see Gregor, “Baumgarten’s ‘Aesthetica,’” 377) who argues that Baumgarten’s two definitions result from “a shift in perspective from metaphysician to philosopher of art.” See also Beiser, *Diotima’s Children*, 146. Guyer, *History of Modern Aesthetics*, vol. I, 328) furthermore points out that the second definition is no new insight in *Aesth.* but can already be found in *Met.*

¹² Descartes, *The World and Other Writings* and Fontenelle, *The Plurality of Worlds*.

¹³ Meier, “Daß das Wesen der Dichtkunst in unserer Natur gegründet sei,” in his *Frühe Schriften*, vol. III, 162 (my translation). On Baumgarten’s reference to Fontenelle see his lectures from c. 1750-51 in his *Aesth.*, 90.

¹⁴ In specifying two types of the perfection of cognition, Baumgarten’s and Meier’s accounts diverge from the traditional rationalist conception of sensory cognition as a merely subordinate insight into what can be cognized more distinctly through reason. As Baumgarten puts it, sensible cognition is an “analogon rationis,” an alternative species of cognition that is equally valuable as rational insight (*Met.*, §640). For an account of these diverging paths see Guyer, *History of Modern Aesthetics*, vol. I, 318–340.

¹⁵ According to Baumgarten and Meier, the perfection of sensible cognition can be taught and learnt, and it is the purpose of aesthetics, the “science of sensible cognition,” to spell out the rules and principles (*Aesth.*, §1, my translation). In *Met.*, §533, Baumgarten also defines aesthetics as the “logic of the inferior cognitive faculties.”

¹⁶ Meier, “Historical and Beautiful Sciences,” in his *Frühe Schriften*, vol. I, 141 (my translation).

¹⁷ Kant’s aesthetics is often understood as inspired by a rejection of rationalism (e.g. Guyer, *Kant and the Claims of Taste*, 119ff., and Allison, *Kant’s Theory of Taste*, 1ff.). Other commentators, by contrast, have stressed the continuities between Kant and the rationalists (e.g. Zuckert, “Kant’s Rationalist Aesthetics”). As I argue in this paper, Kant is strongly influenced by, but importantly reinterprets, key rationalist ideas including the distinction between the logical and aesthetic perfection of cognition (see §4 below).

¹⁸ See e.g. CPR, A15/B29. Kant also leaves room for a priori cognition, such as mathematical or transcendental cognition, which has a more complex relation to sensibility than ordinary empirical cognition. For the purpose of this paper, I shall set aside this complication as well as the general question of how Kant’s transcendental idealist conception of cognition relates to rationalist metaphysics and epistemology. As will become clear in the following discussion, however, Kant’s reinterpretation of the logical and aesthetic perfection of cognition, and his more general account of the beauty of science, are intricately connected with this question.

¹⁹ *Critique of Judgment* (henceforth CJ), 5:204.

²⁰ CJ, 5:204.

²¹ For an outline of Kant’s account of cognition see CPR, A78/B103.

²² On Kant’s distinction between determining and reflecting judgments, see CJ, 5:179.

²³ The arguments I have presented so far may raise the questions of whether or not aesthetic judgment should be regarded as a form of cognition *at all*, and of whether aesthetic judgment should be classified as (indeterminately) *conceptual* or, rather, as altogether *non-conceptual*. See the exchange between Ameriks, “Kant and the Objectivity of Taste” and *Interpreting Kant’s Critiques*, and Ginsborg, *The Role of Taste in Kant’s Theory of Cognition and The Normativity of Nature: Essays on Kant’s Critique of Judgment* on these questions. For the purpose of my argument, I do not need to settle this debate here. Instead, it will be sufficient to show what both parties can agree on, namely, that on Kant’s theory the experience of beauty is necessarily linked to our cognitive, albeit purely reflective, engagement with the object, but it is not itself an instance of determinate cognition. As I argue in more detail below, the indeterminate reflection by means of concepts but not the determinate subsumption under concepts leaves room for the experience of beauty.

²⁴ CJ, 5:236.

²⁵ CJ, 5:190. On the controversial notion of form that Kant employs in his aesthetic theory, see the discussion in Zuckert, “The Purposiveness of Form: A Reading of Kant’s Aesthetic Formalism.”

²⁶ CJ, 5:304.

²⁷ Baumgarten’s and Meier’s general criteria of aesthetics are in principle unavailable for Kant, since judgments of beauty do not stand in any determinate relationship to the character of the object or its representation. Kant first makes this point in CPR, A21/B35, note, before spelling it out in detail in CJ, e.g. 5:284. Beiser (*Diotima’s Children*, 136) criticizes Kant’s “simple-minded” portrayal of the rationalist conception of a science of beauty, expressed e.g. in Kant’s

claim that in such a science “it would be determined... scientifically, i.e., by means of proofs, whether something should be held to be beautiful or not” (CJ, 5:305). Beiser’s critique is that, pace Kant, rationalists such as Baumgarten never thought beauty could be inferred a priori from general principles, but rather presented such principles as a means of explaining aesthetic pleasure. Even if this is right, however, Kant’s critique nevertheless has force. On Kant’s account, we must reject even explanatory principles, since objects stand in no determinate relation to aesthetic pleasure.

²⁸ CJ, 5:305.

²⁹ CJ, 5:305. That aesthetic objects must be sensory is often assumed in contemporary aesthetics. See e.g. Binkley, “Piece: Contra Aesthetics,” 268, and Beardsley, *Aesthetics: Problems in the Philosophy of Criticism*, 31. In “The Problem of Non-Perceptual Art,” Shelley’s discussion of conceptual art gives a convincing argument against this view and finds historical support in the work of Hutcheson. In “Kant and the Problem of Strong Non-Perceptual Art” Costello probes Shelley’s critique further by drawing on Kant.

³⁰ See CJ, 5:326.

³¹ In parallel with the rationalists’ two notions of beauty, Kant thus introduces a second conception of aesthetic judgment, specifically concerned with the beautiful representation of art (compare note 13). Moreover, just as the two rationalist concepts were closely related, in the same way Kant’s two types of aesthetic judgment have a common core. Both consist in the free play of the faculties and the associated awareness of fit that grounds aesthetic pleasure.

³² Kant calls such representations “aesthetic ideas” (CJ, 5:314). For a discussion of this notion, see Chignell, “Kant on the Normativity of Taste: The Role of Aesthetic Ideas.”

³³ CJ, 5:326.

³⁴ CJ, 5:317.

³⁵ CJ, 5:190.

³⁶ CJ, 5:309.

³⁷ CJ, 5:305 and CPR, A838/B866. See also CPR, A832/B860 and CJ, 5:381. Kant only rarely uses the term “science” in a wider sense such as, for example, in the introduction to CPR where he distinguishes the more or less secure paths, and the more or less thorough methods, of science (Axii).

³⁸ Similarly, Kant’s anthropology lectures make use of Baumgarten’s *Met*; see the translators introduction in Kant, *Anthropology, History and Education*, 228.

³⁹ Similar to Baumgarten and Meier, Kant understands perfection as involving “manifoldness and unity” and “the fitness or adequacy of a thing for all sorts of ends” (*Critique of Practical Reason*, 5:41). See also his *Metaphysics of Morals*, 6:386.

⁴⁰ *Jäsche Logic* (henceforth *JL*), 9:37.

⁴¹ According to Kant, sensory representation may come in different forms. In the case of empirical concepts, examples can fulfill this function. In the case of pure a priori concepts, schemata will have to guide their application to sensory material. And, where concepts cannot be applied in sensibility at all, symbolic representation is required. See CJ, 5:351 ff., and the prize essay “Welches sind die wirklichen Fortschritte...?” 20:279–280.

⁴² *Mrongovius Anthropologie Nachschriften* of 1784-85 (25:1224–1228), my translation; see also *Friedländer Anthropologie Nachschriften* of 1775-76 (25:482–484).

⁴³ For a brief discussion of the logical and aesthetic perfection of cognition, see Jankowiak and Watkins, “Meat on the Bones: Kant’s Account of Cognition in Anthropology Lectures,” 74–75. They argue that, “where the Critique explains the necessary, a priori structures of cognition, the anthropology transcripts explain the contingent, empirical modes in which the faculties operate in everyday cognition.”

⁴⁴ JL, 9:36–37. Kant uses similar formulations throughout the 1770s–1790s; see *Blomberg Logic*, 24:43ff., *Wiener Logic* (henceforth WL), 24:807 and *Dohna-Wundlacken Logic* (henceforth DL), 24:705.

⁴⁵ DL, 24:705.

⁴⁶ JL, 9:39; see also JL, 9:62 and WL, 24:809.

⁴⁷ On the relation of aesthetics to the expression of moral ideas, see Guyer, *Kant and the Experience of Freedom*.

⁴⁸ See e.g. CJ, 5:326.

⁴⁹ CJ, 5:314.

⁵⁰ See CPR, A832/B860.

⁵¹ See e.g. CPR, A646/B676.

⁵² Kant presents this move from the principle of the unity of cognitions to that of the unity of the object of cognitions as the move from a logical to a transcendental principle. See CPR, A648 ff./B676 ff.

⁵³ See Kant’s discussion of symbolic representation in CJ, 5:351 ff.

⁵⁴ See e.g. Ball, *Elegant Solutions: Ten Beautiful Experiments in Chemistry*.

⁵⁵ Other beautiful examples can be found in Förster’s account of Hegel’s and Goethe’s early biological research, in particular Goethe’s experiments with plants in his *Die 25 Jahre der Philosophie*.

⁵⁶ CJ, 5:308-9. See also *Anthropologie Nachschriften*, 25:1061 and 1310–11.

⁵⁷ CJ, 5:185. See also Kant’s related discussion in the Appendix to the Transcendental Dialectic (CPR, A653–654/B681–682) and at JL, IX 132–133.

⁵⁸ In CPR, Kant conceives of this reflection as the capacity of seeing the universal in the particular, an ability Kant famously regards as a talent, or “mother wit,” which cannot be taught by rote but can only be gained through practice (A172/B133).

⁵⁹ CJ, 5:184–185. Kant here refers specifically to the unity of empirical laws. Under the heading of judgment as “the capacity to think the particular under the universal” he is equally concerned with the more basic unity of the sensory manifold under concepts (CJ, 5:179).

⁶⁰ Ginsborg (2015) and Zuckert (2007b) argue, in different ways, for the related claim that there is a common form of judging at the core of Kant’s aesthetics and his account of cognition. This claim is a close cousin of my proposal about the continuity between the production of art and science, since the same capacity is involved in producing art and in judging aesthetically. On the question of continuity between aesthetic and determinate conceptual judgments, see also Longuenesse, “Kant’s Leading Thread in the Analytic of the Beautiful,” and Makkreel, “Reflection, Reflective Judgment, and Aesthetic Exemplarity.”

⁶¹ For an impressive description of this kind of aesthetic experience in science, see Heisenberg, “The Meaning of Beauty in the Exact Sciences,” 6–7.

⁶² CJ, 5:309.

⁶³ CJ, 5:187. See also CJ, 5:363.

⁶⁴ See CJ, 5:366.

⁶⁵ CJ, 5:187.

⁶⁶ See e.g. CJ, 5:319.

⁶⁷ CJ, 5:187.

⁶⁸ CJ, 5:187.

⁶⁹ This is compatible with Zammito's claim that Kant's views on genius were influenced by his rejection of the German *Sturm und Drang* movement, most notably Herder, whose anti-rationalism Kant famously criticizes (*The Genesis of Kant's Critique of Judgment*, 41–42). In his "Gerard and Kant: Influence and Opposition", Guyer has furthermore suggested that Kant's views on genius were influenced by, and directed at, Alexander Gerard's *Essay on Genius*. See also Giordanetti's "Das Verhältnis von Genie, Künstler und Wissenschaftler in der Kantischen Philosophie: Entwicklungsgeschichtliche Betrachtungen" for a discussion of Kant's change of mind about the notion of genius.

⁷⁰ I've said a bit more about this question in Breitenbach, "Aesthetics in Science: A Kantian Proposal."

⁷¹ A consequence of this is that the ideal (and in principle unattainable) complete science could not be an object of aesthetic appreciation on Kant's account, since it would provide a determinate representation of the unity of nature and, hence, leave no room for indeterminate reflection.

⁷² Baumgarten, "Handschrift," 90 (my translation); see also *Aesth.*, §8 and *Vern.*, §32.

⁷³ Earlier versions of this paper were presented at the University of Western Ontario, the Central European University, the University of Essex, the University of Bonn, the Leuven Kant

Conference and Yale University. I am grateful to the audiences at these events for their helpful feedback. Special thanks go to John Callanan, Yoon Choi, Alix Cohen, Paul Guyer, Tiago Mata, Sasha Mudd, Clinton Tolley, Eric Watkins, and Nick Zangwill for stimulating discussions, and to the anonymous referees of this journal for reports that helped me improve the paper. Last but not least, I gratefully acknowledge the support of the Leverhulme Trust and CRASSH, Cambridge for funding my research.