Epistemic Engagement, Aesthetic Value & Scientific Practice

Penultimate Version, Forthcoming in the British Journal for the Philosophy of Science

Adrian Currie

Department of Sociology, Philosophy & Anthropology, University of Exeter.

Abstract

I develop an account of the relationship between aesthetics and knowledge, focusing on scientific practice. Cognitivists infer from 'partial sensitivity'—aesthetic appreciation partly depends on doxastic states—to 'factivity', the idea that the truth or otherwise of those beliefs makes a difference to aesthetic appreciation. Rejecting factivity, I develop a notion of 'epistemic engagement': partaking genuinely in a knowledge-directed process of coming to epistemic judgements, and suggest that this better accommodates the relationship between the aesthetic and the epistemic. Scientific training (and other knowledge-directed activities), I argue, involve 'attunement': the co-option of aesthetic judgements towards epistemic ends. Thus, the connection between aesthetic appreciation and knowledge is psychological and contingent. This view has consequences for the warrant of aesthetic judgment in science, namely, the locus of justification are those processes of attunement, not the aesthetic judgements themselves.

1. Walking through time

The Jurassic coast straddles South-West England's Dorset and Devon, almost 100 miles of eroded cliffs and hidden coves built from red sandstone, clays and shale. Exploring the coast, we step through layers of history. From the Napoleonic wars the coast was a favourite for British holidaygoers, hence the Victorian touches: gazebos and seaside boardwalks. Tourism and rich fossil deposits led to the coast becoming a hotbed of nineteenth-century geology, remembered via fossil shops, local museums, and tours. Humans have lived here for millennia: Beer's limestone quarry notes time's passage via underground arches ranging across Gothic, Norman, Anglo-Saxon and Roman architectural styles. And the exposed cliffs speak to the region's Mesozoic history. As imagined by Le Beche in the 1830s, during the Jurassic this was an inland sea, a realm of souring pterosaurs and alien aquatic reptiles, plesiosaurs, ichthyosaurs and their kin; during the Triassic a desert, and the Cretaceous a swamp.

On the Jurassic Coast, historical knowledge and aesthetic appreciation are intimate bedfellows. It is tempting to say that knowing about the coast's history deepens our appreciation, and that such appreciation—seeing the cliff's strata with an aesthetic eye, say—is critical for that knowledge. I will analyse this connection, paying special attention to its role in

scientific practice.
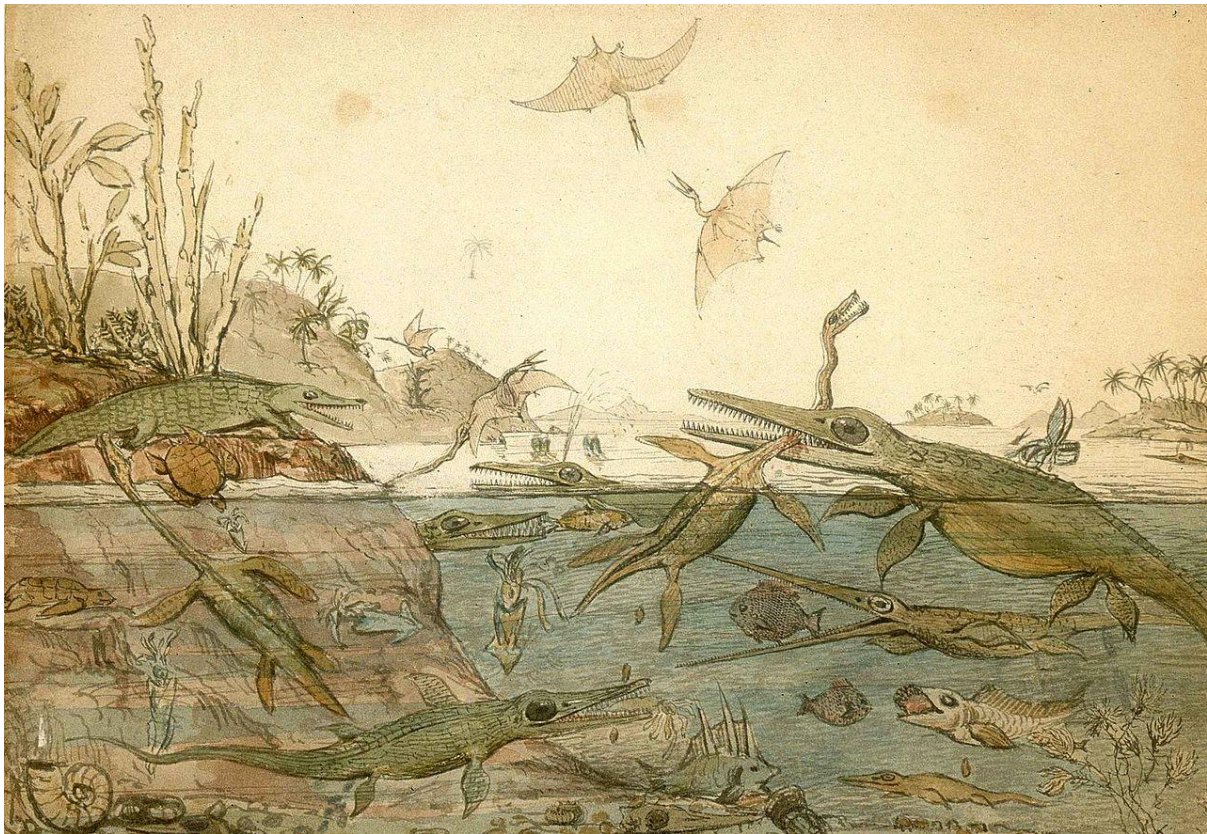
I'm going to argue that the relationships between aesthetic value and judgement, and scientific knowledge, are best understood via psychological (as opposed to conceptual, semantic or metaphysical) connections. In brief, scientific training co-opts and develops scientists' aesthetic judgements, training their aesthetic faculties towards various epistemic purposes. On this view, scientists see aesthetic value in their instruments, data, explanations, and the worlds these reveal, not because there is a direct connection between truth and beauty (or, more carefully, between aesthetic engagement and epistemic success), but because scientific training teaches us to see truth as beautiful (or, more carefully, scientific training 'attunes' aesthetic judgment to epistemic purposes). This has upshots for understanding scientific success and

justification: if my view is right, then the justification of scientists' aesthetic judgements turns on the epistemic practices and training that elicit their judgements.

I'll develop my view by considering Derek Turner's ground-breaking *Paleoaesthetics* ([2019]). There, Turner develops and defends what he calls 'historical cognitivism', the idea that knowledge of an object's history enriches our aesthetic appreciation of that object. He further argues that understanding how the epistemic and aesthetic intermingle is necessary for explaining scientific success. Although I endorse the latter claim, I'll present two objections to historical cognitivism. First, a conceptual argument decoupling truth from aesthetic appreciation; second, an argument from scientific practice, appealing to widespread 'useful falsehoods'. I'll then introduce 'epistemic engagement', arguing it better explains the connection between knowledge and aesthetic appreciation, particularly when tied to a psychological thesis concerning the co-option of aesthetic sensibilities in scientific training. I'll briefly turn to the justification of scientists' aesthetic judgment in the conclusion.

I should clarify our aesthetic and epistemic targets. Distinguish high- and low-falutin' conceptions of aesthetics. *High-falutin'* conceptions decouple aesthetic judgments and sensibilities from our particular idiosyncratic contexts, desires and aims. Kant's conception of aesthetic value, involving the disinterested 'pure' consideration of an object's beauty vis-a-vis form, is high-falutin' (Ginsborg [2019]) as is Plato's. *Low-falutin'* conceptions see aesthetics as connected to, or continuous with, other judgements and our baser pleasures and desires. My approach is firmly low-falutin': on more ineffable conceptions it is difficult to imagine how aesthetic sensibilities could be richly embedded with the more-or-less mundane day-to-day scientific practices we're concerned with[1]. Following this, I'll not concern myself much with the

---

[1] Is this conception too permissive, loading the dice in my favour by infusing any human activity with aesthetic content? I tend to think aesthetic appreciation is embedded within human activities, but regardless, my argument would run *mutatis mutandis* on more restrictive conceptions of low falutin' aesthetic value (machinery from everyday aesthetics might be useful for that project, see Saito 2019)

nature of aesthetic judgment or sensibilities: I'll consider various scientific activities (geological sketches, for instance) to be unproblematically aesthetic insofar as they engage aesthetic sensibilities and involve aesthetic value.

The majority of philosophy concerning the connections between aesthetics and epistemology have focused on apparently aesthetic values such as 'simplicity' in theory acceptance, exploring the possible connection between a hypothesis' 'loveliness' and its 'likeliness' (Lipton [2003]). Philosophers ask after the aesthetic values of theories and their relationship to justification, that is, do beautiful (or 'graceful', or 'unified') theories indicate epistemic success? Perhaps through some meta-induction[2] (McAllister [1999], Kuipers [2002]), or by playing a role in the coherence of scientific judgment (Thagard [2015]), or by indicating understanding (Ivanova [2017b]).

My view follows the spirit of James McAllister ([1999]), who also appeals to learning processes in co-opting aesthetic judgments, painting the connection between aesthetics and epistemology in psychological hues. However, we differ. I'll not begin by considering the justification of scientific products like theories, but instead their practices: the processes of knowledge-production scientists engage in. McAllister is theory-focused and is interested primarily in how aesthetic judgments about theories might matter for those theories' justification. He also argues for a meta-inductive link between aesthetics and epistemology. By contrast, in the conclusion I'll argue that the justificatory role of aesthetic (or other non-epistemic) values in science should be understood in the context of the practices they are geared towards and the relevant pedagogical processes which produce and maintain them. Like McAllister's, my view maintains a deep (if psychological) connection between our knowledge of nature and the richness of our aesthetic considerations of it.

---

[2] That is, aesthetic judgements have previously been linked to successful theories, and so are likely to in the future.

2. Historical Cognitivism

Cognitivism about nature connects aesthetic appreciation with knowledge: true beliefs about nature improves aesthetic judgements (Carlson [2005], [1981], Saito [2008], Matthews [2008]). The view is traditionally developed in comparison with cognitivism about art. Just as knowing the correct artistic categories is required for correctly aesthetically appreciating artistic products (cognitivists claim) so are the correct natural categories required for making correct aesthetic judgements about nature. And those natural categories are provided by science: 'aesthetically appreciating nature requires knowledge of the different environments of nature and of its systems and elements' (Matthews [2008], 37)[3]. Cognitivists emphasize how aesthetic judgements shift with changes in belief. Discovering that a painting is a forgery doesn't simply lower the painting's financial value, but makes a difference to aesthetic appreciation. Cognitivism explains such changes in judgement by claiming that mistaken knowledge about the painting leads to mistaken aesthetic judgements. I'll take Derek Turner as my representative cognitivist due to his relatively moderate account and his focus on scientific practice. I'll start by summarizing Turner's view, before turning to two objections which motivate my account.

2.1 Paleoaesthetics

By 'historical cognitivism', knowledge of an object's history enhances our aesthetic appreciation of that object. Turner develops the view by examining the practices of historical scientists: palaeontologists, archaeologists and geologists. Many scientific practices are tightly knit with artistic ones, such as the artistry of fossil preparation (Wylie [2015]), sketches in geological fieldwork, and the appreciation of biological function. For Turner, it isn't simply that

---

[3] For more on the relationship between aesthetic judgment and background knowledge see Danto ([1981]) and Goodman ([1976]).

knowledge feeds into aesthetic appreciation, but that aesthetic appreciation is required to explain scientific success.

> On the one hand, historical cognitivism shows how the epistemic dimension of the paleosciences contributes to aesthetic engagement with fossils and landscapes. On the other hand, Caitlin Wylie's work shows how aesthetic practices such as fossil preparation make an indispensable contribution to scientific inquiry. This suggests that the aesthetic and epistemic dimensions of paleoscience render mutual support. But that, in turn, suggests that it is a mistake to try to work out the epistemology of historical science without also exploring paleoaesthetics. (Turner [2019], 18)

I agree with Turner's second hand, and my view makes headway on how aesthetic sensibility plays a role in scientists' epistemic activities. Turner rightly emphasizes the critical importance of aesthetic judgement and sensibilities in shaping research: identifying when an experiment is working well, say, or determining the significance of a new discovery. Turner and I part on that first hand.

Here's his version of historical cognitivism:

> Knowledge of living things and natural systems – including knowledge of the history of those things – deepens and enhances our aesthetic engagement with those things, relative to various kinds of naïve engagement. (Ibid, 20)

Turner's view is ceteris paribus: according to historical cognitivism, holding an agent fixed other than their knowledge, they will have richer aesthetic engagement with more knowledge than less. So, were I to be otherwise the same, but knew less about the history of the Jurassic Coast, my appreciation of its natural beauty would decrease. Many objections to cognitivism target its systematicity (Carroll [2013], Stecker [1997]): even if knowledge sometimes increases aesthetic appreciation, surely it needn't always. Discovering new facts about an object of

appreciation might decrease appreciation. However, sophisticated cognitivists needn't claim a direct connection between beauty and truth; what matters for their view is that new knowledge shapes or deepens aesthetic sensibility. And deeper aesthetic appreciation needn't involve beauty: new knowledge might reveal ugly depths. In light of this, I'll describe the phenomenon at hand as *partial sensitivity*: sensitivity between aesthetic judgement and knowledge is only partial because changes in beliefs do not necessitate changes in aesthetic appreciation. On my view, this is because their connection is psychological and depends on features of the agent and their context.

So, for my purposes, there are two components of Turner's view worth highlighting. First a *factive* component: true belief constrains aesthetic judgement. Second, as we've seen, *partial sensitivity*: our aesthetic judgements change in light of our doxastic states. These are logically independent: an agent might change their doxastic states, and this may affect their aesthetic judgment, without changes in factivity. According to partial sensitivity I might, for instance, develop false beliefs about the Jurassic Coast, and this might deepen (or otherwise) my aesthetic engagement; it is only factivity that demands those beliefs be true. Consider Turner's discussion of Robert Elliot's thought experiment ([1982]), which compares a genuine Vermeer with a forgery:

> Two paintings can be qualitatively identical, but if they have different histories, we might justifiably value them differently… If you have false beliefs about that painting… then your aesthetic engagement with the artwork is misfiring in at least one important way. (Turner [2019], 10)

In having false beliefs about the forgery, I'm not simply making an epistemic mistake, I'm making an aesthetic mistake. For Turner our aesthetic appreciation is both sensitive to our beliefs and to our knowledge states: getting it right counts. On his view, 'false beliefs about the past undermine aesthetic engagement in a significant way' (22).

2.2 A conceptual objection

I've highlighted two components of Turner's account: factivity and partial sensitivity. I think his arguments favour the latter but not the former:

> The basic argument in favour of historical cognitivism is just that it is the only view that can make sense of such cases, where revising our beliefs about an item's history completely changes the character of our aesthetic engagement with that item. Aesthetic judgements about things are sensitive to beliefs about history (Turner [2019], 23).

No doubt how I value something depends in part on my beliefs, but it doesn't follow that my beliefs must be true[4]. The historical cognitivist claims that ceteris paribus, aesthetic appreciation increases with knowledge. The crucial comparison for testing factivity, then, involves two agents who have equally-well-grounded beliefs about an object, but where one belief is false and the other is true. On such comparisons, I'll argue, factivity is implausible. In making this conceptual argument, I hope you'll forgive me for taking liberty with two historical figures who perhaps philosophers of science have abused enough: Tycho Brahe and Johannes Kepler.

Both Kepler and Brahe were intimately concerned with patterns governing the heavens, spent hours intensely studying their subject (although Kepler tended towards abstract mathematical pondering and Brahe laborious data-gathering) and made important scientific contributions (see Jardine [1984] for a more responsible treatment). However, we now think that Kepler got something right that Brahe didn't. Brahe departed from the Ptolemaic system by

---

[4] Another context where 'factivity' is denied is recent defences of the epistemic good of understanding (e.g., Potochnik [2017], Elgin [2018], De Regt [2015]). My discussion differs. First, such accounts deny the link between two epistemic goods: truth and understanding, while mine splits truth from aesthetic appreciation. Second, on these accounts truth plays an important role: to understand some phenomenon we must get it *true enough*. That is, truth still constrains the realm of understanding. This might be plausible for understanding, but I provide reasons for denying that truth plays any direct role in constraining aesthetic judgement or appreciation (although no doubt, through epistemic engagement, the two are indirectly linked). Recently Elgin ([2020]) connects aesthetics with understanding, but again we part on the role of truth in the same way.

placing the planets in orbit around the sun, however his sun orbited a stationary Earth. Meanwhile, Kepler's Earth moved. Philosophers in the mid-twentieth-Century made much hay of this difference. Here's Hanson describing the two watching a sunrise:

> Tycho sees the sun beginning its journey from horizon to horizon. He sees that from some celestial vantage point the sun (carrying with it the moon and planets) could be watched circling our fixed earth. Watching the sun at dawn through Tychonic spectacles would be to see it in something like this way. Kepler's visual field, however, has a different conceptual organization… But Kepler will see the horizon dipping, or turning away, from our fixed local star. (Hanson [1958], 23)

Hanson is interested in the theory-laddeness of observation, suggesting that Brahe and Kepler's differing theoretical frameworks led to perceptual differences: they in fact see differently. Let's not worry about that. Instead, let's consider the two men's aesthetic experiences (we'll briefly consider other aspects of aesthetic appreciation below). Should we consider Brahe's aesthetic experience of a moving sun less aesthetically rich than Kepler's aesthetic experience of a fixed sun because the sun is in fact fixed (relative to the Earth)? Let's imagine both have spent equal time struggling with astronomical theories, gathering observational data, and simply gazing heavenward—they are, in the parlance I'll adopt below, equal in *epistemic engagement.* According to factivity, we should accord them different aesthetic appreciation. To paraphrase Turner, Brahe's aesthetic appreciation is misfiring in at least one important way. Regarding aesthetic experience at least, I don't think we should agree: the thought that the truth or otherwise of Brahe's hard-won beliefs would make a difference to his aesthetic experience is a strange one. To see this, imagine now the same scenario—Brahe and Kepler gazing at a sun rise—except we are in a Brahonic world. It is Kepler whose appreciation is misfiring in at least one important way. By my lights, holding fixed our agents but altering the

truth of their beliefs doesn't change their aesthetic experience: switching between Keplerian and Brahonic worlds, I think, suggests aesthetic experiences are not sensitive to the facts.

Factivity makes aesthetic engagement turn on the wrong kind of thing. Brahe and Kepler's aesthetic experience is equal both in worlds with stationary and shifting suns. Notice—and this leads us towards 'epistemic engagement'—that making Brahe and Kepler equal in depth of aesthetic experience involved equalizing their 'epistemic labour' (and equalizing other features such as, say, differing inclinations to enjoying sunrises).

Imagine now that Kepler's mum watches a sunrise, and let's imagine that despite her ignorance of astronomy she believes the sun is stationary, as her son told her. In this scenario, although Kepler's mum hasn't spent long considering the heavens, her aesthetic judgment compared to Brahe is firing in at least one important way: she correctly appreciates the sun 'rising' due to a shifting Earth. With due respect to Kepler's mum, this is the wrong thing to say: it is the long periods of study—again, of epistemic labour—which affords Kepler and Brahe their knowledge-based aesthetic experience[5]. Not whether they happen to be right or not. If Brahe's dad had been there, and trusting in his son's wisdom believed he watched a sun whizzing about a stationary earth, I don't think his aesthetic experiences would have been any worse or better than that of Kepler's mum simply on the basis of one happening to be right, and the other happening to be wrong. Of course, if Brahe were to find out that the Earth moved, this might change his aesthetic appreciation of sunrises, but this is just partial sensitivity: aesthetic judgements turning on doxastic states. But that is not factivity. Let's consider four responses.

First, by Turner's account the relevant comparison is not two agents, but an agent and a more naïve copy. The comparison is not between Kepler and Brahe, but between them and their comparatively ignorant counterparts. This is fair, but I can accommodate this subtlety. Compare

---

[5] (at least in part, of course, features of the agent such as their aesthetic capabilities also play a role: but the thought experiment asks us to hold these fixed)

the actual Kepler with a possible Kepler who, despite performing the same epistemic labour, believes in a stationary Earth (or the actual Brahe with his more correct counterpart). As above, there do not here seem to be grounds for claiming that Kepler has better aesthetic appreciation simply because he has a true belief.

Second, you might object that Brahe is very knowledgeable about astronomy: he is not naïve in the relevant way. And indeed 'knowledge' goes beyond the mere possession of particular propositional truths. We might, then, adopt a broader reading of knowledge that includes a broader set of epistemic goods—understanding, applicability, transferability, and so forth. Indeed, both Turner and myself adopt such a pluralistic conception of the epistemic. But take this too far and you lose factivity: Brahe no longer aesthetically misfires due to a false belief.

A third objection complains that I've conflated aesthetic appreciation with aesthetic experience. As there is more to the aesthetic than experience[6], we might agree that the truth or otherwise of Brahe and Kepler's beliefs won't change their experience of the sunrise, but insist that truth makes a difference to other aspects of their aesthetic lives. Perhaps truth matters for aesthetic reflections on sunrises? Again, it doesn't seem that our being in a Brahonic or Keplerian world makes a difference to the depth of the two men's memories of, or surmisings after, the sunrise's aesthetic properties. Indeed, an important aspect of such reflection is building connections between differing objects of aesthetic appreciation, and it may be that Brahe, armed with his false beliefs, is better-positioned to draw some aesthetic connections than Kepler. For instance, Brahe's retention of an Earth-centred universe affords connections between the structure of the heavens and various religious beliefs about our place in the cosmos. So, at least in principle false beliefs might make for richer aesthetic reflections than true. My claims about aesthetic experience, then, *prima facie* extend to aesthetic appreciation broadly construed.

---

[6] Thanks to an anonymous referee for this excellent point.

Fourth, you might be concerned about my employment of an intuition pump: surely arguments in the philosophy of science shouldn't be decided on the basis of thought experiments. I share this worry, but it is important to see where the argument gets us. It puts the notion of 'epistemic labour' on the table, and highlights a point of disagreement between myself and cognitivists. Where they see (something akin to) a conceptual link between aesthetic and epistemic sensibilities and judgments, I see it as built from epistemic labour. This is a crucial plank in my positive view. Finally, the argument doesn't stand alone, but complements an argument from scientific practice: let's turn to that now.

2.3 An objection from scientific practice

By factivity, aesthetic appreciation is sensitive to truth. Further, for Turner aesthetic values are rife through scientific practice. However, many scientific practices are carried out in full awareness of falsity, particularly those involving idealization: representations which do not only abstract from how the world is—omission—but distort it (Levy [forthcoming], Weisberg [2007], Cartwright [1984]). As Kwame Anthony Appiah has put it, idealizations involve 'useful untruths' (Appiah [2017], 1), representations that we know are false but nonetheless serve important epistemic purposes (see also Wimsatt [1987]). 'In idealization, we build a picture—a model—of something that proceeds *as if* something we know is false were true' (Ibid, 127, original italics). Understanding untruths can generate bountiful knowledge. Angela Potochnik has recently argued that idealizations play a more central role in science than philosophers have recognized.

> … idealizations are both rampant and unchecked in science. By *rampant*, I mean that idealizations are found throughout our best scientific products, and they stand in for even crucial causal influences. By *unchecked*, I mean that little effort is put towards eliminating or even controlling these idealizations. (Potochnik [2017], 40-41)

On Potochnik's view, truth-departing idealizations are found everywhichwhere we look in science, and cannot be explained away as merely omitting unimportant details. Consider human behaviour: classical economists model us as utility-maximising rational actors; behavioural ecologists model us as adopting strategies to maximize our fitness within our local social environment; evolutionary psychologists model us as ruled by psychological mechanisms which evolved in response to Pleistocene environments. These scientists know that real human behaviour is not utility nor fitness maximizing, nor are we helpless servants of our evolutionary pasts. Scientists simulating galaxy and solar-system formation, using agent-based models to understand ecological communities, exploring black holes using fluid mechanical experiments, and so forth, know their models depart radically from the natural systems they're interested in. Such scientists often think their empirical tools and frameworks are useful even though they depart from reality. Adam Toon puts the philosophical challenge nicely: 'how are we to make sense of the fact that a large part of scientific practice seems to involve talking and learning about things that do not exist?' (Toon [2012], 2). Toon's solution, and of many others, is to adopt fictionalism about models (Levy [2012], Frigg & Nguyen [2016], Godfrey-Smith [2009a]). Model systems are not representations of real systems, but of pretend systems. Such scientists are engaging in a kind of epistemically rich pretence.

Several philosophers—Potochnik in particular—argue that rampant idealization underwrites doubt about whether truth is a primary scientific goal, often pointing towards 'understanding' as a better fit. Milena Ivanova ([2017b], [2020]), for instance, suggests the disconnect between truth and scientific practice should lead us to think of aesthetic appreciation in particular as geared towards understanding. As we'll see, there are important connections between my positive view and hers, but I'll avoid committing to a particular epistemic good such as understanding; scientific values and goals are too varied and too tied to local context to be amenable to monistic treatments.

The challenge for historical cognitivism is this: if aesthetic value, like idealization, is rampant and unchecked in science, then factivity about aesthetic value is puzzling. Factivity connects aesthetic appreciation and truth, while unchecked idealization suggests indifference to truth. If cognitivism is true, then scientists' aesthetic sensibilities should be tied more-or-less directly with truth-generation. But insofar as idealizations lead us to truth, the route is complex and indirect. One needn't adopt as all-pervasive a view on idealizations as Potochnik, nor fictionalism about scientific models (indeed, I don't: Currie [2017]), to see the problem. If aesthetic judgements are as widespread in scientific practice as Turner argues, especially if aesthetic judgements play a role in shaping and guiding scientists, and the aesthetic is made more rich via truth, then scientists spending so much time intimately engaged with tools and techniques which they explicitly do not believe to be true is mysterious. Further, insofar as aesthetic judgement serves as a guide for scientific practice—if aesthetic sensibility is rampant through science—then presumably it plays a critical role in the employment of useful falsehoods. And it is unclear how cognitivism can make sense of this.

One might insist that idealizations are true nonetheless, perhaps by adopting a pragmatic theory of truth, whereby 'useful untruths' become somewhat oxymoronic, or by attempting to argue that idealizations are true after all. I'm open to the first suggestion, although such an account takes us far from the intuitions motivating factivity. On the second suggestion, no doubt there is much truth in science. But it is critical for a view like Turner's that aesthetic judgement plays a guiding role in scientific practice, that is, that aesthetic value and judgement feeds directly into scientists' generating truth. Even if idealizations, circuitously and surprisingly, are often involved in truth-generating practices (and indeed some are), this indirectness sits uncomfortably with the direct connection between aesthetic judgment and truth that cognitivists require. Happily, by dropping factivity and replacing it with what I'll call 'epistemic engagement' we can reconcile idealization with aesthetic value.

3. Aesthetics and Epistemology without Factivity

I've provided two objections to factivity. The objection from scientific practice emphasized that many aspects of scientists' daily work departs from the construction of accurate—fact-based—representations. The conceptual objection argued that it is epistemic labour, not truth, which makes a difference to aesthetic appreciation. My aim in this section is to first, develop a notion of epistemic engagement which captures these two thoughts while cohering with partial sensitivity; second, use this to reconceptualise the relationship between epistemology and aesthetics. Knowledge doesn't help us see beauty, learning helps us see knowledge as beautiful. We've two questions then. What is the relationship between epistemic activity and aesthetic appreciation which explains partial sensitivity? How does aesthetic appreciation feed into epistemic practice? In 3.1 I'll answer the former, in 3.2 the latter.

3.1 Epistemic Engagement

Thi Nguyen has argued that although 'aesthetic judgements can be straightforwardly correct or incorrect' ([2019], 3), correctness isn't the point of forming aesthetic judgements: for Nguyen, the value of forming aesthetic judgements is the activity of aesthetic engagement.

> … the value of aesthetic appreciation lies in or arises from the processes of engagement involved in forming aesthetic judgments. 'Aesthetic engagement' here includes our higher-level cognition of aesthetic objects: searching for connections, rethinking interpretations, discovering affective resonances, and so on. It also includes low-level forms of engagement such as perceptual engagement: actively shifting one's attention from one perceptual detail to the next, and then assembling these details into a larger structure. And it includes the way these forms of engagement feed into one another… (Ibid, 11).

Nguyen argues that while aesthetic engagement is the search for aesthetic truth, the value of aesthetic engagement is not in the final product—some judgment of aesthetic value—but in the process itself[7]. Nguyen draws a contrast with science: '… science and art appreciation have very different purposes. In art appreciation, we *aim* at making correct aesthetic judgements. But having correct aesthetic judgments isn't the *purpose* of the practice… On the other hand, we demand indirect autonomy in empirical life because we significantly value getting things right, and that value often outweighs the values associated with doing things for ourselves' (10). Nguyen is interested in testimonial contexts, where scientists are experts, rather than scientists' aesthetic and epistemic goals per se. However, considering the two lessons from the last section: that many scientists knowingly employ 'useful untruths', and that aesthetic appreciation seems to track epistemic labour rather than truth, it seems Nguyen draws science and art appreciation too far apart.

I think a notion of 'epistemic engagement', closely paralleling Nguyen's idea, better captures how epistemic hard-yards bring aesthetic dividends, thus capturing what Kepler and Brahe hold in common—their epistemic labour—despite their differences vis-à-vis getting it right. Like Nguyen's concept epistemic engagement is purposefully broad. It is, at base, the process of developing epistemic judgments. Examining a section of strata and deciding it formed in the Jurassic, or considering some hypothesis and reckoning it well-founded, say. More carefully:

> To be *epistemically engaged* is to partake genuinely in a knowledge-directed process of coming to epistemic judgements.

A process is 'knowledge-directed' when those engaged in the process believe the process is likely to generate knowledge. When I take my friend's word that some section of strata hails from the Jurassic, this is because I believe I've good reason to take them as having the relevant

---

expertise, thus their testimony vis-à-vis the strata is a way towards knowledge. Thus, the process is knowledge-directed. I'll take 'epistemic judgements' broadly: philosophers have discussed many epistemic goods, from truth to understanding, to judgments about explanatoriness, and so on. A judgment is epistemic just in case it is towards one of those goods (or 'bads' for negative judgements). By 'genuine' I mean to partake in a knowledge-directed process in order to gain knowledge, as opposed to, say, ironically or for some other purpose. Disingenuous epistemic engagement doesn't foreclose gaining knowledge, but matters here for capturing partial sensitivity. If Brahe doesn't care about getting it right, then it isn't so obvious to me that correcting his beliefs about sunrises would make a difference to his experience of them. Epistemic engagement makes sense of how Brahe and Kepler might be equal in epistemic labour: they have genuinely engaged equally in various processes of coming to epistemic judgments about the heavens.

Nguyen is right that an upshot of epistemic judgment (engagement) can be the truth. But that is not its only fruit. Another is deepened aesthetic appreciation. The last section's discussions suggest a connection between epistemic engagement and aesthetic appreciation, and that such engagement deepens appreciation regardless of the epistemic judgement's truth. This accommodates partial sensitivity: the activity has to be considered knowledge-directed by the agent—if Brahe were to learn that his judgement about the sun's movement was in error, he would likely change his aesthetic appreciation of the sunrise—but knowledge-direction is doxastic. That is, the scientist *believes* that engaging with that object will lead to them learning things. Scientists working with idealizations do not (or shouldn't) believe these are veridical representations, but they nonetheless have conviction that working with, examining, considering—epistemically engaging—with such representations will lead to insight, understanding, and other kinds of knowledge.

So, to be epistemically engaged is to partake genuinely in a knowledge-directed process of coming to epistemic judgements. Epistemic engagement explains partial sensitivity without factivity because although processes of belief formation can enrich aesthetic engagement, the epistemic judgments arrived at need not be true for that aesthetic payoff. Learning that a scientific practice is not knowledge-directed—that it generates misunderstanding, say—leads to changes in aesthetic appreciation. The economist, let's imagine, who previously found deep satisfaction in understanding the behaviour of large-scale society in terms of individual economic self-interest, upon coming to believe that the idealization is epistemically pernicious, might no longer find that satisfaction. Learning that your model is not knowledge-directed can change aesthetic appreciation towards both model and target system.

Epistemic engagement takes myriad forms. A modeller explores a new iteration; an experimenter probes after confounding variables; a field geologist scans the horizon hunting for tell-tale signs of stratigraphic variation; an archaeologist painstakingly marks out a future excavation site. But also: a journalist drafts a piece on a scientific discovery, a lecturer sketches the contours of a scientific theory, a parent reads *Quantum Physics for Babies* to their child. Each of these activities can involve partaking in a genuinely knowledge-directed process. And, plausibly, each doesn't only bring epistemic dividends but aesthetic ones too. When my friend points out a layer of red sandstone along the Jurassic coast, explaining these are the remains of a long-ago—180 million years old—drowned desert, they draw my attention to the sandstone's rich colour, its patterns of sedimentation and erosion, and help me view the current shape and sweep of the coast as the result of millions of years of geological toing and froing. With a good enough imagination, perhaps, they help me see the landscape as dry and dusty, and haunted by the ghosts of long-dead Triassic denizens. And indeed, I might come to see myself a speck adrift in a great sea of time, part of a grand unfolding narrative. Even if my friend happens to be wrong,

if, like Brahe, they've false beliefs despite their epistemic engagement, this doesn't deny me the attention to detail, new appreciation and aesthetic payoff[8].

This leaves open just what the connection between epistemic engagement and aesthetics is. In virtue of what does engaging in a knowledge-directed process of coming to epistemic judgements bring aesthetic fruits? As we'll see, my answer will connect epistemic engagement with what I'll call 'attunement': aesthetic judgment being co-opted towards, and becoming enmeshed with, epistemic judgement.

3.2 Attunement

Thus far, I've argued in favour of partial sensitivity: changes in our beliefs (often) make a difference to our aesthetic appreciation, and argued against factivity: our aesthetic appreciation doesn't turn on getting things right. In light of this, I've developed a notion of epistemic engagement, which is to genuinely partake in a knowledge-directed process of developing epistemic judgements. I've suggested that epistemic engagement explains partial sensitivity, as a product of such engagement is deeper aesthetic sensitivity. But what is the nature of this product: are knowledge and aesthetics connected via necessary, conceptual, semantic or metaphysical links? I think the connection between truth and beauty is contingent, and due to the kinds of beings we happen to be. In becoming scientists, aesthetic judgements are co-opted for scientific purposes. That is, aesthetic faculties are 'attuned' to science's epistemic purposes. My argument is empirical and speculative, but nonetheless I think the gambit a good one, and will collect some considerations in favour of it[9].

---

[8] My account is officially uncommitted vis-à-vis the objectivity of aesthetic judgment. I prefer to think of 'better' or 'deeper' aesthetic appreciation as relativized to the processes of attunement at hand.

[9] I am not assuming a homogenous conception of how humans aesthetically appreciate—far from it— Our species' diversity is reflected in our aesthetic faculties and sensibilities.

Turner emphasizes the aesthetic sensibilities involved in geological fieldwork, a common theme in field-based sciences. Consider the geologist Haakon Fossen's reflection on field sketches.

> Geology is, by nature, a field-based branch of science, and making on-site sketches is the best way to approach an outcrop. Why? Because field sketching sharpens your senses and turns you into a much better observer. It forces you to focus, to make important decisions regarding crucial structures and features, such as cross-cutting relations, sequence boundaries, fault geometry, layer continuity and grain size variations. It makes you discover important details that otherwise might go unnoticed. And it makes the locality stick to your mind. (Fossen [2013])

Sketching geological formations is important for training students to see like geologists: picking out pertinent details, learning how to represent them; making judgements about what is of epistemic import in geological formations (Turner [2019]). Similar might be said of fieldwork in archaeology. Archaeologists are keenly aware that extraction, required for the production of archaeological knowledge, is destructive (Chapman & Wylie [2016]). The fieldworker continually makes judgement calls about what to extract, how, and what information to retrieve. Archaeological interpretation, as Ian Hodder infamously put it, 'occurs at the trowel's edge' (Hodder [1999], 83). Caitlin Wylie has emphasized similar in fossil preparation:

> ... distinguishing coveted fossilized bone from useless rock requires the tacit knowledge of expert visual judgment and manual skill to reveal the fossil by destroying the rock (i.e., the process of fossil preparation). Because of this, the same starting rock can result in a variety of different specimens. (Wylie [2019], 24).

So, these kinds of knowhow do not simply matter for observation, but interpretation. And, as Turner emphasizes, this knowhow has an undoubted aesthetic quality. But whence comes this quality? Reflecting on scientific training leads us to an answer.

Recently, philosophers of science have rethought Thomas Kuhn's legacy, in particular, de-emphasizing his notion of 'scientific revolutions' and their attendant worries about incommensurability, in favour of his idea of 'normal science' (see, for example, Godfrey-Smith 2009b). In brief, Kuhn argues that normal science is built around a 'paradigm', which begins as a work considered an exemplar of how to do science of that type (Kuhn [1962]). For instance, Augustus Pitt-Rivers' late-nineteenth-Century excavations of Roman and Saxon remains were influential both in terms of what was collected (everything, not just fancy-looking specimens) and how they were categorized (according to an evolutionary typology of human culture). Although the latter aspect is long discarded, the methodical and analytical approach he adopted was an exemplar for later archaeologists (Hamilton [1999], Chapman & Wylie [2016]). And indeed, some of Pitt-Rivers' techniques became codified in best-practices, discussed in archaeological publications, taught in universities, and so forth. Such exemplars provide a kind of template for how to do a kind of science: what sorts of questions to ask, what sorts of methods to use in data collection and interpretation, what kinds of evidence is satisfactory, and so forth. Sticking with archaeology, that generations of archaeologists have attended similar field sites, undergone similar trading—been faced with the same kinds of decisions and provided with the same conceptual and physical toolkits to respond—plausibly plays an important role in those archaeologists sharing a more-or-less common conception of what archaeology is.

This Kuhnian perspective adds a layer to our discussion of geological fieldwork. It isn't only that fieldwork matters for learning skills and interpretation, but that shared and similar experiences in the field generate common skills and common methods of interpretation. Such are the material practices from which a paradigm is made. So for fieldwork, so also for work in

the lab, work in the undergraduate lecture theatre, and informal discussions in the hallway, café or pub.

I'll describe these various social practices and shared experiences as 'attuning' scientist to paradigm; provisioning them with the conceptual apparatus, skills and perspective of a scientist of that type. I understand attunement broadly: it is a multifactorial process incorporating perception, motivation, judgement, both tacit and explicit knowledge as well as skills and expectations. Through a process of attunement an agent's perceptual and conceptual apparatus are geared towards the goals and purposes of that activity. My psychological gambit is that these processes of attunement often coopt an agent's aesthetic repertoire towards epistemic aims. Field sketching, as Fossen discusses it, doesn't simply teach the mechanical and epistemic skill of recording relevant information about a geological site, the activity also trains aesthetic sensibilities. The scientist learns which sketches and which sites look 'good', the differences between ugly and well-ordered strata, and so forth.

McAllister's similarly psychological account is often read via the mechanism of 'exposure' (e.g., Ivanova [2017a]), and contrasting this with attunement is instructive. (It is worth noting that McAllister doesn't explicitly appeal to exposure and it may be that attunement, as I characterise it, is what he has in mind). 'Exposure' is taken from psychology: at base, it is the idea that simply spending time with (being 'merely exposed to') art is enough to increase reported liking of said art (e.g., Cutting [2003]). So, perhaps pedagogical processes in science inculcate a positive aesthetic regard for what is being taught via repeated exposure. Students repeatedly studying and practicing, say, field sketching techniques will, by exposure, end up considering such techniques and their products with aesthetic approval. It has been questioned both whether 'mere' exposure leads to positive aesthetic judgement (Meskin et al [2013]) and whether it is sufficient for the complex job aesthetic judgments play in science (Ivanova [2020]). Likely exposure plays some kind of role in attunement, but what I have in mind is richer than entrained

positive aesthetic regard. To demonstrate, I'll say more about how attunement meshes aesthetic and epistemic judgement.

It might be tempting to read scientific aesthetic judgments in expressivist terms (e.g., Todd [2004]). That is, the aesthetic content of epistemic phenomena are not properly-speaking judgements, but positively or negatively valanced responses. On this picture, the aesthetic is a thin veneer which guides the epistemological, propositional business of science. I think expressivism is an open position given what I've said, and especially so if we think exposure is the right account of 'attunement'. However, I doubt it captures the connection between the aesthetic and the epistemic in scientific practice. Instead, I'll suggest they're more closely-knit than this.

Anna Alexandrova ([2016], [2017]) has developed a notion of a *mixed claim*, which is a scientific hypothesis that is 'thick' in something like Ryle's sense. Here's her definition:

'A hypothesis is mixed if and only if

1. It is an empirical claim about a putative causal or statistical relation.
2. At least one of the variables in this claim is defined in a way that presupposes a moral, prudential or political value judgement about the nature of this variable' (Alexandrova [2017], 82).

Although Alexandrova's definition covers hypotheses, she is clear that mutatis mutandis we can have 'mixed theories, mixed measures, and more generally mixed sciences' (82). For instance, measuring a population's self-reported life satisfaction is an empirical activity, yet those who do it either explicitly or implicitly assume that such information is a good proxy for wellbeing. Alexandrova argues that the science of wellbeing (and other social sciences generally) are constructed from such mixed claims—and moreover that mixed claims are here to stay.

I think many of the scientific judgments we've been discussing: which part of the cliff to represent in a drawing, how to excavate an archaeological site, how to prepare a fossil, what makes for an interesting iteration of a model, a good guiding research question, or intervention on an experimental system, are 'aesthetically mixed judgements'. Their content involves interweaving aesthetic and epistemic judgements. This is due to processes of attunement: the scientists' perceptions, motivation, judgement, skills and expectations are turned towards scientific practices and purposes. This includes both perceptual capacities, skills and motivational systems. The preceding discussion makes plausible that these motivational systems are often— although not always—aesthetic (in the low falutin' sense). As a scientist develops their skill and knowledge, they also learn that discipline's, subfield's or (even) lab's aesthetic perspective. The aesthetic and the epistemic aspects are intimately linked. Science does not only involve aesthetically mixed hypotheses, judgements and standards, but also mixed skills, expectations and knowhow. We might artificially, for explication, split the aesthetic from the epistemic, but these are abstractions on our part. This explains the close-knit connection between some aesthetic and epistemic theoretical virtues. For instance, notions of 'simplicity' are often discussed as if they are unproblematically epistemic, and sometimes as being unproblematically aesthetic. If I'm right, this is because both aspects are interwoven in aesthetically mixed judgements. They are paradigmatically epistemic and paradigmatically aesthetic simultaneously.

So, where exposure is a psychological mechanism whereby repeated interaction with an object increases our positive aesthetic regard for it, attunement is a processes whereby aesthetic judgements, sensibilities and capacities are tuned to epistemic purposes, thus producing aesthetically mixed judgements and capacities.

Milena Ivanova's recent ([2020]) discussion of the connection between aesthetics and scientific judgement also provides a useful contrast case. Like me, she emphasizes the contingent, psychological connection between aesthetic regard and knowledge. However,

Ivanova argues that the aesthetic qualities of scientific theories are reflections of our cognitive preferences:

> [aesthetic properties] are properties of our theories only because we decided to construct them in such a way, and we decide to construct them this way because it is most convenient for us to operate with theories that satisfy our aesthetic and intellectual requirements. (Ivanova [2020], 90)

On Ivanova's view, there are stable aesthetic preferences 'deeply ingrained in human thinking' (89) which are reflected in the aesthetic properties of scientific theories. Aesthetic preferences come first, driving theory construction; our theories are 'attuned' to pre-existing aesthetic preferences. On the attunement view aesthetic preferences are much more dynamic; the aesthetic properties of our theories (and other scientific products and practices!) are not the product of more-or-less innate preferences, but are structured and turned towards epistemic goals through pedagogical processes.

Turner discusses what he calls 'aesthetic-epistemic feedback effects', whereby our aesthetic appreciation and knowledge of nature feed into, structure and motivate one another:

> Not only does historical research make for richer aesthetic engagement, but aesthetic engagement can also deepen and enhance scientific investigation. Aesthetic engagement and historical investigation are mutually facilitating. (Turner [2019], 29).

Especially in pedagogy, such feedback loops undermine Ivanova's one-way connection from aesthetics to knowledge. The aesthetic difference between, say, a physicist who prizes highly controlled, precise experimentation and the anthropologist who embraces the rich, complex ambiguity of an ethnographic report lies in part on the differing feedbacks they partook of during their training. Epistemic engagement with experimentation or ethnographies involves developing aesthetic appreciation geared towards them, and as Turner would have it that

developing appreciation enhances and feeds into the scientists' epistemic prowess vis-à-vis those practices. In attunement, aesthetic sensibility and judgments meet and entangle with epistemic practice.

For example, Kirsten Walsh and I (Currie & Walsh [2019]) discuss what we call 'explanatory expectations' to highlight differences in individual historians' ideas about which explanations of historical phenomena are acceptable. Explanatory expectations are generated by a scientist's training in addition to peculiarities of the explanatory target. Terms like 'elegant', 'satisfactory', 'powerful' and so forth, are often applied to various explanations, and how these are applied differ across contexts. A palaeontologist used to complex narrative explanations of change across macroevolutionary time will have quite different 'instincts' regarding what a good explanation 'looks like' (Currie [2019]) than, say, a classical economist trained to analytic proofs. A plausible psychological story concerning explanatory expectations could appeal to the oft-discussed 'aha moment': a phenomenal feeling of satisfaction accompanying an explanation (Kounios & Beeman [2009]). Alison Gopnik ([1998]) has suggested that we consider the *aha* aspect of an explanation as analogous to orgasm: as orgasm is tied to our motivational systems towards sex, so is the aha moment how our motivational systems lead us towards knowledge.

Aha moments as signals of explanatory expectations being met are perhaps the most obvious case of an aesthetic response—satisfaction, a sense of completeness or closedness—being adapted to an epistemic purpose. But I think such phenomena are varied and widespread. Aesthetic sensibility plays a role in scientists' detecting completeness, their explanatory expectations, what counts as a puzzle, and what is unsatisfactory. Aesthetic responses guide scientists in generating evidence—monitoring whether an experiment is proceeding correctly, whether a result 'looks right', and whether a hypothesis is plausible. Further, negative aesthetic judgments, a hypothesis' 'ugliness', say, drives science both by guiding practice, setting problems and—potentially—leading to both epistemic and aesthetic shifts as epistemic labour does its

work. Science's normativity plays out in an aesthetic mode. However I doubt this aesthetic mode relies on deeply engrained aesthetic judgments as Ivanova would have it. It is an open question just how plastic our aesthetic responses are—and I've not sufficient space here to develop the thought—but reflecting on the wide, often clashing, pluralism of scientific judgements about explanatory and evidential adequacy, sufficiency of practice, and so forth, my bet is on plasticity.

There is nothing about the aesthetic or the epistemic conceptually that makes them bedfellows. It is due to contingent features of ourselves as knowers and aesthetic appreciators. Conceivable beings who learn differently, or appreciate differently, might not exhibit the same mixed aspects, and might then make for very different scientists. This view decouples the objectivity of aesthetic or epistemic judgment from their relationship. We are not required to commit to the objectivity or otherwise of aesthetic judgment, nor epistemic judgment, in order to see their rich connection.

4. Conclusion: Practice & Justification

With epistemic engagement and attunement in place, I'll conclude with a few comments regarding the justification or otherwise of scientists' aesthetic judgments. That is, when a scientist expresses aesthetic approval (or disapproval) or some claim, how does that guide us vis-à-vis epistemic justification?

Philosophers have approached this question in several ways. First, they've asked whether aesthetic judgments might be grounded in the nature of evidence; second, they've asked whether there might be local background knowledge underwriting those preferences. Take the plausibly-aesthetic 'simplicity'. Why grant epistemic preference to simpler theories (when simpler theories are preferred)? It could be that, prima facie, a simpler theory is more likely to be true because, say, of the rules of likelihood. Or it might be that there's no simplicita defence of simplicity, instead some local knowledge grounds expectations of simplicity in some domain.

Elliot Sober, for instance, has argued for the latter regarding phylogenetic parsimony (Sober [1981]). In short, because evolutionary theory leads us to expect relatively robust ancestral relations, we should expect similarity between lineages to be due to common ancestry. Thus, we should prefer evolutionary trees with fewer changes in traits. Further, others have argued that justification lies in meta-induction, coherence or understanding. Here, I want to provide a non-mutually exclusive third option: If scientists' aesthetic judgments are the result of attunement through epistemic engagement, then their trustworthiness doesn't turn on the aesthetic judgment itself, but on those processes of attunement. In light of this, we should attend to the epistemic properties of the training, practices and engagement from which the aesthetic judgements arise, not the aesthetic judgments themselves, if we are to judge their trustworthiness.

Consider the mixed skills learned via geological fieldwork. Presumably geologists attuned in those ways will be adept at correctly identifying strata and will judge landscape in part based on those capacities: so, a 'nicely ordered' or even 'beautiful' stratigraphic form will be easily read, a 'fascinating' strata might be in some way puzzling, while an 'ugly' or 'messy' sequence will be one with an unclear geological signal. To tell whether we should trust these judgments, we should ask after the process of attunement the geologist has undergone: the kinds of strata they are used to, for instance.

One upshot is the locality of scientist's aesthetic judgments. Explanatory expectations which work well in one context can misfire in another. But such misfiring is not unanalysable. Judgements might be transferable if the practices of attunement are to relevantly similar epistemic situations. But they might not be transferable: subtleties might matter. For instance, paleontologists tell me that getting to know a new locality—its quirks and personality—takes time even for those otherwise experienced. Although I think this answer can be considered

complementary to existing accounts of the justification of aesthetics in science, there is one clash: meta-inductive defences. Consideration of these returns us to our earlier Kuhnian theme.

Above I linked attunement with Kuhn's 'normal science'. James McAllister also appeals to Kuhnian themes in his psychological account of the connection between aesthetics and scientific knowledge. Focusing on Kuhn's revolutions, he argues that theory-change in science involves shifts in aesthetic value; it is not just our knowledge which changes, but the 'aesthetic canon' as well. This co-evolution is sometimes in lock-step, sometimes in tension. McAllister emphasizes the continuity in scientists' aesthetic judgments across apparent revolutions:

> … while a community's aesthetic canon changes with time, the aesthetic preferences of scientists at any one time do not diverge very strongly: there is wide agreement about the aesthetic properties that theories should possess. This is because, far from being conceived at whim, scientists' aesthetic preferences are formed in a communitywide induction over the empirical performance of past theories. (McAllister [1996], 137-138).

So, for McAllister, although aesthetic value is dynamic, the past successes of theories ensure more-or-less continuity across epistemic changes, and indeed the previous success of theories underwrites the goodness of scientists' aesthetic judgements. This 'aesthetic induction' ensures the relative conservativeness of aesthetic judgements in science across time. When revolutions happen, McAllister considers them in terms of 'aesthetic ruptures': 'as the repudiation of aesthetic constraints that a community had become accustomed to imposing on theory choice' (131). So, on McAllister's view, we see science as typically—often—continuous across apparent changes in theory due to continuity in aesthetic judgements maintained via learning and justified via the aesthetic induction. However, it is occasionally rocked by aesthetic ruptures (revolutions) where the community is split between an old-guard sticking to the old aesthetic canon and a new group embracing a new set of aesthetic preferences.

For McAllister, then, the justification of aesthetic preferences over normal science relies on an induction across a past history of success. On the fact of it, this clashes with the locality I've emphasized (see Ivanova [2020] for a more systematic critique of McAllister). This is because the aesthetic induction relies on aesthetic values being sufficiently similar. If, via processes of attunement, aesthetic sensibilities are dynamic and local, then such inductions are untenable. There's much more here to be said. It may be that for the Theories which McAllister focuses on we do see the kinds of continuity that underwrites his view, while for other aspects (fieldwork, say) things are how I have painted them. Determining under what contexts scientists' aesthetic sensibilities are sufficiently similar to warrant an inductive treatment requires a proper examination of local contexts. Regardless, if processes of attunement—and their subsequent aesthetic judgements—are local, then meta-inductive arguments like Kuiper's ([2002]) and McAllister's become weaker, as such inferences depend upon continuity across the inductive base, which localism undermines.

If something like the view I've defended here is right, then we've an attractive story about how the epistemic and the aesthetic interact. As I learn about the Jurassic Coast—epistemically engage with it—this process attunes my aesthetic sensibilities to those features highlighted by my knowledge: its Victorian gazebos, smuggler's coves and Mesozoic formations. And these sensibilities further guide my interest and investigation, deepening that epistemic engagement. Whether or not truth is beautiful, epistemic engagement leads me to see it as such.

Bibliography

Alexandrova, Anna. (2017). A Philosophy for the Science of Well-being. Oxford University Press.

Alexandrova, Anna. (2016). Can the science of well-being be objective?. The British Journal for the Philosophy of Science, 69(2), 421-445.

Appiah, Kwame Antony. (2017). As if: Idealization and ideals. Harvard University Press.

Berleant, Arnold. (2010). Art and engagement. Temple University Press.

Carlson, Allen. (2005). Aesthetics and the environment: The appreciation of nature, art and architecture. Routledge.

Carlson, Allen. (1981). Nature, aesthetic judgment, and objectivity. The Journal of Aesthetics and Art Criticism, 40(1), 15-27.

Carroll, Noel. (2013). On being moved by nature: Between religion and natural history. In Arguing about Art (pp. 188-207). Routledge.

Cartwright, Nancy. (1984). How the laws of physics lie. Oxford University Press.

Chapman, Robert., & Wylie, Alison. (2016). Evidential reasoning in archaeology. Bloomsbury Publishing.

Currie, A., & Walsh, K. (2019). Frameworks for historians and philosophers. HOPOS: The Journal of the International Society for the History of Philosophy of Science, 9(1), 1-34.

Currie, Adrian. (2019). Simplicity, one-shot hypotheses and paleobiological explanation. History and philosophy of the life sciences, 41(1), 10.

Currie, Adrian. (2017). From Models-as-fictions to Models-as-tools. Ergo, an Open Access Journal of Philosophy, 4.

Cutting, J. E. (2003). Gustave Caillebotte, French impressionism, and mere exposure. Psychonomic Bulletin & Review, 10(2), 319-343.

Danto, Arthur. (1981). The transfiguration of the commonplace: a philosophy of art. Harvard University Press.

De Regt, H. (2015), 'Scientific understanding: truth or dare?' Synthese 192: 3781-3797.

Elgin, C. Z. (2020). Epistemic Gatekeepers: The Role of Aesthetic Factors in Science. In The Aesthetics of Science (pp. 21-35). Routledge.

Elgin, C. (2018), True Enough. MIT Press.

Elliot, Robert. (1982). Faking nature. Inquiry 26(1), 81–93.

Fossen, Haaokon. (2013). Do You Sketch in the Field? Structural Geology Blog https://structuralgeo.wordpress.com/2013/11/20/do-you-sketch-in-the-field/, accessed 20/11/2019.

Frigg, Ramon., & Nguyen, James. (2016). The fiction view of models reloaded. The Monist, 99(3), 225-242.

Ginsborg, Hannah (2019). Kant's Aesthetics and Teleology, The Stanford Encyclopedia of Philosophy, Zalta (ed.).

Godfrey-Smith, Peter. (2009b). Theory and reality: An introduction to the philosophy of science. University of Chicago Press.

Godfrey-Smith, Peter (2009a). Models and fictions in science. Philosophical studies, 143(1), 101-116.

Goodman, Nelson. (1976). Languages of art: An approach to a theory of symbols. Hackett publishing.

Gopnik, Alison. (1998). Explanation as orgasm. Minds and machines, 8(1), 101-118.

Hamilton, Sue. (1999). Lost in translation? A comment on the excavation report. Papers of the Institute of Archaeology, 10, 1-8.

Hanson, Norwood. (1958). Patterns of discovery: An inquiry into the conceptual foundations of science (Vol. 251). CUP Archive.

Hodder, Ian. (1999). The Archaeological Process. An Introduction. Oxford: Blackwell.

Ivanova, M. (2020). Beauty, Truth and Understanding. In The Aesthetics of Science (pp. 86-103). Routledge.

Ivanova, Milena. (2017a). Aesthetic values in science. Philosophy Compass, 12(10), e12433.

Ivanova, Milena. (2017b). Poincaré's aesthetics of science. Synthese, 194(7), 2581-2594.

Jardine, Nick. (1984). The Birth of History and Philosophy of Science: Kepler's'a Defence of Tycho Against Ursus' with Essays on its Provenance and Significance.

Kuhn, Thomas. (1962/2012). The structure of scientific revolutions. University of Chicago press.

Kuipers, Theo. (2002). Beauty, a Road to the Truth. Synthese 131 (3), 291-328.

Kounios, John. and Beeman, Mark. (2009). The Aha! Moment : The Cognitive Neuroscience of Insight. Current Directions in Psychological Science, 18: 210–16

Levy, Arnon. (forthcoming). Idealization and abstraction: refining the distinction. Synthese.

Levy, Arnon. (2012). Models, fictions, and realism: Two packages. Philosophy of Science, 79(5), 738-748.

Lipton, Peter. (2003). Inference to the best explanation. Routledge

Matthews, Patricia. (2008). Scientific knowledge and aesthetic appreciation of nature. In A. Carlson and S. Lintott, eds., Nature, Aesthetics, and Environmentalism: From beauty to duty. New York: Columbia University Press, pp. 188–204.

McAllister, James. (1999). Beauty and revolution in science. Cornell University Press.

Meskin, Aaron., Phelan, Mark., Moore, Margaret., & Kieran, Mattew. (2013). Mere exposure to bad art. British Journal of Aesthetics, 53(2), 139-164.

Nguyen, C. Thi. (forthcoming). Autonomy and aesthetic engagement. Mind.

Potochnik, Angela. (2017). Idealization and the Aims of Science. University of Chicago Press.

Saito, Yuriko. (2008). Appreciating nature in its own terms. In A. Carlson and S. Lintott, eds., Nature, Aesthetics, and Environment: From beauty to duty. New York: Columbia University Press, pp. 151–168.

Saito, Yuriko (2019). Aesthetics of the Everyday. The Stanford Encyclopedia of Philosophy Edward N. Zalta (ed.).

Sober, Eliott. (1981). The principle of parsimony. British Journal for the Philosophy of Science, 32(2), 145-156.

Stecker, Robert. (1997). The Correct and the Appropriate in the Appreciation of Nature. The British Journal of Aesthetics, 37(4), 393-402.

Thagard, Paul. (2005). Why is beauty a road to the truth?. In Cognitive structures in scientific inquiry (pp. 365-374). Brill Rodopi.

Todd, C. Samual. (2004). Quasi– Realism, Acquaintance, and The Normative Claims of Aesthetic Judgement. The British Journal of Aesthetics, 44(3), 277-296.

Toon, Adam. (2012). Models as make-believe: Imagination, fiction and scientific representation. Springer.

Turner, Derek. (2019). Paleoaesthetics and the Practice of Paleontology. CUP.

Weisberg, Michael. (2007). Three kinds of idealization. The journal of Philosophy, 104(12), 639-659.

Wimsatt, Willam. (1987). False models as means to truer theories. Neutral models in biology, 23-55.

Wylie, Caitlin. (2019). Overcoming the underdetermination of specimens. Biology & Philosophy, 34(2), 24.

Wylie, Caitlin. (2015). 'The artist's piece is already in the stone': Constructing creativity in paleontology laboratories. Social studies of science, 45(1), 31-55.