

# Methodological lessons for the integration of philosophy of science and aesthetics: The case of representation

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## 1. Introduction

Philosophers of science and philosophers of art have increasingly joined forces to tackle a range of contemporary debates in epistemology and metaphysics. This expanding literature is in fact a particular manifestation of a much broader trend that has tried to bring art and science together in modern times, not only through a philosophical lens but also by tracking shared historical episodes and identifying common practices. In this paper, I will focus on the analysis of a specific subset of that heterogeneous literature that tries to connect art and science, namely, recent attempts to integrate discussions on scientific and artistic representation.

Particularly in contemporary philosophy of science, there is a manifest tendency to refer to examples and concepts from art to illustrate or support arguments concerning scientific representation. In 2006, Callender & Cohen wrote a paper entitled ‘There is no special problem about scientific representation’, where they openly questioned the genuineness of the problem of *scientific* representation and urged philosophers to examine it in the context of wider debates in philosophy of language, philosophy of mind or aesthetics. Other attempts to connect the problems of scientific and artistic representation can be found in Suárez (1999, 2003, 2004), French (2003), van Fraassen (2008), Downes (2009), Elgin (2010, 2011, 2017), Chakravartty (2010) and Ambrosio (2013). In addition, there is a flourishing literature on fictionalism that has tried to

incorporate modern theories of literary fiction into accounts of representation in science.<sup>1</sup>

Some reasons can be suggested to explain the increasing interest in including elements from art in the debate of scientific representation. One of them relates to the emergence of studies of models in contemporary philosophy of science. The shift towards the study of models, moving away from the idea that scientific theories were the most fundamental units of science, began in the 1960s and gained momentum in the 1980s and 1990s. Philosophers of science usually agree that, despite the great variety of models there are – material, graphical, mathematical – something they have in common is that they are not linguistic entities, at least not in the same way scientific theories were taken to be in the syntactic view. Thus, by emphasizing the non-linguistic character of models, commonalities with artistic products such as paintings, photographs or sculptures emerged. Moreover, these commonalities became particularly useful when philosophers of science investigated the nature of particular manifestations of models such as scientific images, diagrams, scale models or computer simulations.

Another motivation for the reference to pictorial arts in accounts of scientific representation seems to be the more general acknowledgment of the limitations that philosophy of science has when addressing particularly complex problems like representation. Recognizing the strengths of other traditions of thought in dealing with analogous problems can be taken as an act of academic humility, linked to a positive view of what interdisciplinary work can do for contemporary research.

However, the potential benefits of integrating aesthetics and philosophy of science to address the problem of representation are diminished when references to art in this literature happen to be too contingent, sporadic or even misleading. Connections between science and art are occasionally advocated, but without openly questioning how they are justified in epistemological terms and what the gain of doing so is. The field of aesthetics has a long tradition of asking questions

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<sup>1</sup> Literature on fictionalism draws on the idea that modelling practices in science are practices of fiction-making and/or concern fictive entities. The edited volumes *Fictions in Science* by Suárez (2009) and *Beyond Mimesis and Convention* by Frigg and Hunter (2010) contain a good sample of works in this direction. In this paper, I will mainly discuss how philosophers of science incorporate examples and concepts from *pictorial arts*, and will not specifically refer to the use of literary fiction to address the problem of scientific representation.

like: how do pictures represent? How do photographs stand for particular targets in the world? What is the role of similarity in depiction? That tradition has to be carefully and systematically considered if the aim is to establish fruitful links with debates on scientific representation. One of the goals of this paper is to show some problematic consequences of not taking explicitly into consideration important methodological issues concerning how and to what purpose elements from art are incorporated into the debate of scientific representation. The other goal is to vindicate the potential epistemological benefit of bringing aesthetics and philosophy of science together, once the previous methodological issues are adequately considered.

In section 2 of the paper, I identify three different ways of incorporating elements from art into contemporary debates of scientific representation and point out some of the limitations they respectively present. Recent papers by Suárez (2003, 2004), Chakravartty (2010) and French (2003) will help illustrate this point. In section 3, I present some methodological reflections about the integration of philosophy of science and aesthetics, and interdisciplinary work more broadly. Two accounts in recent literature will be discussed to show how the integration of debates in philosophy of science and art can be particularly fruitful to address the problem of representation, namely van Fraassen's (2008) and Elgin's (2010, 2011, 2017) latest proposals.

## **2. Three constraints on the relation between scientific and artistic representation**

It is possible to observe philosophers of science including elements from art in their accounts of scientific representation in at least three different ways. Each of these ways can help bring into light important commonalities between scientific and artistic products, but can also convey some methodological difficulties. The first one is the use of artworks to illustrate certain features of scientific representations. The difficulty in this case can arise when there is no explicit consideration to the aesthetical and historical background in which those artworks were produced. The second one is the use of concepts from theories of modern art to make claims about representation in science. The difficulty here appears when the original meaning of those concepts is partially misleading. And

the third one is the establishment of a direct link between accounts of representation in aesthetics and philosophy of science. In this case, the potential of the strategy can be substantially diminished if there is not enough consideration of the underlying worries that philosophers in each field have.

The first situation refers to the occasional allusion to particular artworks to highlight or uncover a feature of scientific representations. An example of this can be found in the recurring references to Picasso's *Guernica* in recent literature on philosophy of science (see Suárez, 1999, 2003, 2004; French, 2003; Chakravartty, 2010). As Ambrosio (2013) has claimed: 'these cursory references to Picasso's painting occasionally appear in philosophy journals to support, in strangely instrumental ways, entirely contrasting approaches to scientific representation'" (Ambrosio, 2013: 109). Suárez (2003, 2004) uses the example of *Guernica* to defend a deflationary, inferential conception of representation. French (2003) refers to Picasso's painting to support a model-theoretic account of representation based on partial isomorphism. Chakravartty (2010) describes the representational relations in *Guernica* as sustaining an 'approximate truth' conception of the goals of science and art. How is it plausible that *Guernica* strengthens each of these accounts of representation?

Following Ambrosio (2013: 109), we should probably admit that none of these accounts does complete justice to the representational relations governing *Guernica*. References to the painting appear rather in isolation in these works, maybe accompanied by some historical information around the piece, but not taking into consideration some of its defining aspects. Among those aspects, we should include the material decisions made by Picasso during the creation of the work, the specific place of the painting in the history of art (for instance, how it follows the principles of Cubism and how Cubism fits in the panorama of the Avant-gardes) and central aesthetic issues related to the piece more or less directly, such as what abstraction meant for traditional styles of depiction. The status of a painting as an artwork and, more importantly here, as a *representational vehicle* cannot be accurately discussed without considering these central aspects. Fortunately, in the case of *Guernica*, the painting is well documented and has been extensively studied by historians of art (see Arnheim, 1962; Chipp, 1988; Oppler, 1988). Ambrosio specifically suggests that a closer inspection of the process culminating in the final version of *Guernica* – through its over 40 preparatory sketches – can reveal a different and far more interesting story about the practices of representing that underpin it (Ambrosio, 2013: 109).

To give a more specific example, Suárez (2003) uses the case of *Guernica* in the context of defending a specific claim about scientific representations: that similarity is not a constituent of the relation of representation (Suárez, 2003: 233–6). His main concern (Suárez, 2003) is with approaches in philosophy of science that take either similarity or isomorphism to be necessary and/or sufficient conditions for representation. And it is in the pictorial arts where he finds particularly suitable examples to argue against these approaches. For instance, he shows that there are probably some figurative elements in *Guernica* that look like, or are similar to, certain things in the world, such as a weeping woman, a bull or a horse, that we would recognize in the composition. However, we would hardly say that those elements literally resemble, or are similar to, ‘the threat of fascism’, which is the much more intangible target of the painting. This fact demonstrates for Suárez that similarity is not necessary for representation, and more generally that the relation of representation cannot be explained by, or reduced to, a relation of similarity (Suárez, 2003: 236).

Even if the former analysis is undeniably correct, I argue that it is only a small part of the story that explains the representational relations governing *Guernica*. A more complete story would have not permitted the claim that similarity is not necessary for representation without further characterization of how, nevertheless, similarities of appearance are present and play a role in pictorial representations like this one. And this more complete story can only be given by taking into consideration the preparatory sketches of the painting and the aesthetic discussions surrounding its creation and reception, instead of only the piece as an analysable final product. Thanks to the historical record of successive sketches, we know that the aim of the painting was not realistic or figurative representation, as, for instance, Picasso decided to transform a quite realistic drawing of a horse in an early sketch into a more geometricized and abstract version of it (Ambrosio, 2013: 112). At the same time – and this is the key – we also observe that an important means of the continual practice of depicting was the search for relevant similarities that allow the composition to access its more intangible target: the rise of fascism as well as a universal statement against war. This is why the painting progressively gains in pictorial details of some of its components. The mouths and the eyes of the characters in the scene (the woman, the horse, the bull) became more figurative and detailed in later sketches, resembling the expressions of people in great pain (Ambrosio, 2013: 112–14).

At this point, Suárez would claim that the previous issues concern the *means* of the representation, and not the *constituents*, which was his main worry when criticizing the role of similarity (Suárez, 2003: 230).<sup>2</sup> Nonetheless, he specifically stated that none of the visual similarities present in *Guernica* ‘are a good guide to the actual targets of the representation’ (Suárez, 2003: 236). This is exactly what a more complete description of the painting contradicts: selective similarities might not constitute the relation of representation, but they are precisely ‘good guides’ to successfully access the target of the representation, which is anyway far too complex to be exhausted by similarity conceived as a point-to-point correspondence. In short, using cases from pictorial arts in an argument about the general conditions for scientific representation might not be in every case as effective as it might initially have seemed. Introducing an artwork as example, especially if we consider the story of the practices that culminate in it, could result in the challenge of some of the general claims at stake instead of in their plain validation. In this case, paying attention to the different components of *Guernica* might have the effect of triggering new questions about the relations between the *means* and the *constituents* of a representation, or about the goals that define the *means* used in practice.

The second way of introducing elements from art in the debate on scientific representation refers to the appropriation of concepts from art to make claims about representation in science. As part of the volume *Beyond Mimesis and Convention. Representation in Art and Science* (Frigg and Hunter, 2010), Anjan Chakravartty (2010) writes a paper entitled ‘Truth and representation in science: Two inspirations from art’. There he uses terminology originating from theories of modern art and also incorporates examples from abstract and performance arts (including *Guernica* [2010: 45]) as heuristic tools to argue for an approximate truth conception of representation. ‘I believe that analogies to practices of representation in art can serve as valuable heuristics towards understanding how and in what manner scientific representations can be true’ (2010: 33). Chakravartty’s initial intuition must have been that what scientific models and artworks have in common is that they depart in important aspects from the targets in the world they represent, and yet they succeed in providing true characterizations of those targets. Unfortunately, this intuition is never clearly

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<sup>2</sup> Suárez has recognised in several occasions that similarity might be one of the possible *means* of representation (Suárez, 2003: 230; 2004: 768; 2010: 95).

articulated in the paper, and it turns out to be somewhat obscure at highlighting commonalities between scientific and artistic representations.

Chakravartty proposes a triple analogy: ‘realistic’ and ‘non-realistic’ styles of representation (Chakravartty, 2010: 40–41) are considered respectively akin to ‘depiction’ and ‘denotation’ in the arts, and to ‘truth’ and ‘reference’ in the sciences (2010: 45). This implies that there is a correspondence between realistic styles, depiction in art and truth in science. Since Chakravartty sees these notions as degrees in a spectrum, the closer to realistic styles we are, the closer to perfect depiction and truth, and the further from non-realistic styles, denotation and reference. But why assimilate degrees of depiction in art with approximation to truth in science? That would only make complete sense if the main goal of art was perfect depiction, since Chakravartty assumes that truth is the main goal of science. But this is clearly not the case for art. Otherwise, any pictorial style that is intentionally departing from figurative modes of depiction has to be understood as a failure in principle. Even if we accept that approximating truth is the goal of science, having a look to the history of modern arts shows that perfect depiction is not the goal of art.

That being said, it is hard to believe that Chakravartty is trying to claim exactly that about depiction, although the analogy invites us to think in this direction. Probably the reasoning behind the analogy is that Chakravartty considers that seeking or approximating truth is the goal of both science and art, as he affirms: ‘truth in both domains should be understood in terms of approximating reality by means of representation’ (2010: 34). Then, ‘depiction’ and ‘denotation’ would be two possible ways of approximating truth in the arts, while ‘truth’ (in the sense of true characterization of the target) and ‘reference’ would be two ways of approximating truth in science. Even in these terms, the analogy that results is ambiguous. For Chakravartty, the greater the number of relevant properties of a target system a representation describes (regardless of abstractions) and the more accurately it describes them (regardless of idealizations), the closer to truth that representation is (2010: 45). If this is right, idealizations and abstractions are understood as limiting or constraining aspects of representations that should be corrected or improved upon to approximate truth in science. This claim has had several detractors in contemporary philosophy of science (see Elgin, 2004; Elliott-Graves and Weisberg, 2014). At least some idealizations and abstractions in scientific models are not meant to be corrected by incorporating more properties, nor by yielding more information

about those properties. It seems that the analogy with art Chakravartty uses could be supporting the opposite view to the one he is defending: the parallel with art reinforces the idea that abstractions and idealizations can be responsible for the success of representations, instead of being elements that need to be improved upon to reach higher levels of approximation to truth. *Guernica* would not be an *improved* representation of its target by pictorially describing more properties of its target, nor by figuratively yielding more information about those specific properties.

Furthermore, the way in which Chakravartty defends ‘approximate truth’ as the common goal of science and art, alluding to Nelson Goodman’s *Languages of Art* (1968), can be challenged too. *Languages of Art* is probably the work in aesthetics most quoted by contemporary philosophers of science working on the topic of representation. It is mostly cited for its logical argument against similarity<sup>3</sup>, while other important contributions in it, such as those concerning the common aims of science and art, are frequently overlooked. Chakravartty does bring some of these matters to the fore of the debate, but it is open to question whether the concept of approximate truth that he ascribes to Goodman is actually equivalent to the one he is defending.

At one point in *Languages of Art*, Goodman uses the phrasing ‘arriving at the nearest approximation to truth’ (Goodman, 1968: 263) and Chakravartty claims to see a parallel with his own idea (Chakravartty, 2010: 40). However, Goodman made quite clear that truth was neither the ultimate goal of art nor of science and that this was a crucial commonality between the two domains. Particularly in science, he argued, ‘despite rife doctrine, truth by itself matters very little’ (Goodman, 1968: 263). We have to exercise our judgment not on grounds of truth but on the basis of the simplicity or strength of the hypotheses we have. And *this* is the closest to an idea of ‘approximation to truth’ we can appeal to (Goodman, 1968: 263). In a quite different spirit, the concept of approximate truth that Chakravartty proposes is an objective one that can be measured on grounds of the number of properties that a representation shares with its target and the degree of accuracy of those shared properties (Chakravartty, 2010: 45). In conclusion, the attempt to highlight connections between scientific and artistic representations in the case of Chakravartty’s paper is not as acutely successful as

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<sup>3</sup> See for instance: van Fraassen, 2008; Suárez, 2003; French, 2003; Hughes 1997; Contessa, 2007; Frigg, 2006; Toon, 2012.



it might, had the concepts of ‘realistic style’, ‘depiction’ and ‘approximation to truth’ (in Goodman’s sense) been as precisely problematized as they have originally been in aesthetics.

A third possible way of introducing elements from art in the debate on scientific representation is the combination of specific philosophical accounts in aesthetics and philosophy of science. The explanatory potential this strategy has can be reduced if the different underlying concerns that philosophers in each of the fields have are not explicitly considered. To illustrate this point, I refer to Steven French’s (2003) paper ‘A Model-Theoretic Account of Representation (or, I Don’t Know Much About Art... But I Know It involves isomorphism)’, where he draws on Malcolm Budd’s (1993) thesis on isomorphism in artistic depiction. In doing so, French is engaging with an account in contemporary aesthetics that in principle embraces a very similar challenge to his own: explaining representation in virtue of a relation of structural similarity or isomorphism.

However, Budd’s concerns diverge from French’s in very specific but key aspects that make the analogy between the two accounts rather complicated. French’s (2003) main focus of attention is with the constitutional question about representation, namely whether something is a scientific representation of something else. And an adequate answer to this question, he argues, could be given in terms of an isomorphism relation between the target and the source of a representation (French, 2003: 1473). In other words, isomorphism is a good candidate to be a necessary – and even sufficient – condition for representation. In a different vein, the debate in aesthetics in which Malcolm Budd (1993) is immersed assumes, almost without exception among its members, that the notion of similarity (also resemblance, isomorphism) has to be discussed in relation to a different question: ‘how do representations depict?’ or ‘what distinguishes pictorial from non-pictorial representations?’ (Budd, 1993: 217). Budd’s account of isomorphism is not answering the question of what the constituents of representation are, but what makes representations pictorially accurate.<sup>4</sup>

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<sup>4</sup> This relates to Suárez’s distinction between the ‘means’ and the ‘constituents’ of representation (Suárez, 2003: 230). Greenberg (2013) points out different ways in which these two different questions about representation have been phrased in contemporary aesthetics. The question about the ‘means’ of representation can be identified with the question about the singularities of ‘pictorial representation’, the ‘*accuracy* conditions for pictorial representation’ and ‘pictorial content’. On the other side, the question about the ‘constituents’ of representation can be identified with the questions about the ‘conditions for representation’ and ‘pictorial reference’ (reference is different from denotation in Greenberg’s sense) (Greenberg 2013: 222n).

Consequently, the first key difference between the two accounts is that Budd is concerned with pictorial content while French is trying to define conditions for representation.

Now, for the sake of the argument let's assume that both Budd and French were trying to answer the same – and less problematic – question about the *means* of representation with their accounts of isomorphism. Even in that case, the notions of isomorphism they are invoking are originated in different frameworks and respond to dissimilar opponent views in their fields. In his 1993 paper, Budd starts by claiming that the 'obvious and familiar' idea that a picture represent its subject by means of the properties it shares with it is clearly 'naïve and inadequate as it stands' (Budd, 1993: 217). He rejects the old intuition of traditional resemblance theories of pictorial representation that 'for a picture to accurately depict a scene is for the picture itself to resemble the scene' (Greenberg, 2011: 47). In contemporary debates in aesthetics, more refined resemblance theories of depiction can be divided up according to two general conceptions, one that assumes that the similarity in question is real, and the other one that assumes that it is merely experienced (see Greenberg, 2011: 47n; Abell, 2009: 188).<sup>5</sup> The strategy that Budd as well as Peacocke (1987) and Hopkins (1998) adopt corresponds to the second conception. The talk on isomorphism in these approaches only makes sense in terms of internalized perception of the subjects: 'The appearance an object presents to the viewer is dependent upon the point of view from which it is seen, the manner in which it is illuminated, and the mental and visual apparatus of the viewer' (Budd, 1993: 233). Particularly for Budd, experiences of resemblance occur between the *design* of a picture and the *visual field* of the viewer (Budd, 1993: 221).<sup>6</sup>

The ambiguous element in French's argument is that he seems much closer to the 'objective similarity' accounts of depiction than to the 'experienced similarity' ones that Budd holds. French's notion of partial isomorphism invokes

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<sup>5</sup> Dominic Lopes (1996; 2005) refers to these two conceptions as 'objective similarity accounts' and 'subjective or internalized similarity accounts'. In the objective accounts there are similarities between pictures' design (visible properties of the surface of the picture) and the properties of the subjects they represent. And in the subjective accounts our experiences of pictures are experiences of resemblances between designs and the visual field representations of the depicted scenes (Lopes, 1996: 20; and Lopes, 2005: 43).

<sup>6</sup> 'Visual field' is understood here as the abstraction of the way the world is represented in ordinary perceptual experience lacking the third dimension, like if a plane was interposed between scene and viewer (Budd, 1993: 221).

an idea of mapping that exclusively concerns the two objects of the representation, vehicle and target, one being structurally similar to the other. The role of the subjects in this equation is limited to the identification of the existing shared structures, and to fill in, if possible, the partial elements of the mapping, for instance, the relationships that have not yet been established to hold (French, 2003: 1481). He makes clear his ‘objective’ take on similarity when he gives the example of a supposedly natural representation of the Lorentz transformations in the sand, made by the sea and wind. Given the existent isomorphism between the marks carved in the sand and the physical system, French would unproblematically claim that ‘the theory is there’ (French, 2003: 1474). That is, the (partial) sharing of structures of a vehicle and a target is all that is needed to have a representation.<sup>7</sup> In sum, the central role Budd concedes to the subjects intervening in the process of representing reconfigures the notion of isomorphism, to the point that it means something considerably different to what French is assuming it to mean in this view.

Additionally, Stephen Downes (2009) noticed a further difficulty with French’s account: relying on Budd’s proposal was not doing any good for his view, since experienced accounts of similarity have been strongly criticised in recent years in aesthetics (Downes, 2009: 424). The reason for this criticism is the so-called problem of ‘illegitimate internalizing of content’ (Lopes, 1996: 23). Subjective similarity accounts postulate inner pictures with properties of the visual experience that they aim to explain. So these accounts fail to pass the independence challenge (the challenge of explaining how we experience pictures as like their subjects independently of knowledge of what they depict) (Downes, 2009: 424; following Lopes, 1996: 23). The conclusion Downes extracts from this situation goes as follows: ‘a pessimistic outlook is that lessons from aesthetics indicate that philosophers of science should look elsewhere for an account of representation for models’ (Downes, 2009: 420). I believe we do not need to accept

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<sup>7</sup> French tries to highlight divergences between scientific and artistic representations at this point. In the example of the Lorentz transformations, French only needs isomorphism to claim that the marks in the sand represent the natural phenomenon, while in a supposed case of marks looking like a face, he would not say that they represent a face unless there is also a clear intention causing it (French, 2003: 1473). Then, it is not completely clear why French decides to refer to this account in aesthetics in his argument once he recognizes significant difference between representation in art and science. In any case, this conception of scientific representation, that does not require the presence of agents or intentions to exist, has been challenged by numerous contemporary philosophers of science (Suárez, 2015; van Fraassen, 2008; Contessa, 2007; Callender & Cohen, 2006; Giere, 2004).

that pessimistic conclusion about the project of bringing philosophy of science and aesthetics together to dialogue about representation. But maybe one lesson to be learnt is that conceptual differences and internal debates carried out over years in specific philosophical disciplines should not be disregarded when comparing accounts in different fields.

By referring to different papers in recent literature as examples, I have described some ways by which philosophers of science introduce elements from art into their accounts of scientific representation, and some possible difficulties this can entail. More than merely pointing to shortcomings of these accounts, the aim was to bring attention to the important epistemological benefit that current attempts of dialogue between philosophy of science and aesthetics can bring, particularly when the dialogue is established in a thorough and systematic way. In their modern form, aesthetics and philosophy of science have existed as independent fields for at least one century, mainly as a consequence of the specialization of academic disciplines which was consolidated in universities at the dawn of the twentieth century.<sup>8</sup> So even if they are two branches within philosophy, philosophy of science and aesthetics are equipped with distinctive disciplinary tools that organize their agendas of discussion and their internal debates. In the next section of the paper, I present some general methodological reflections about the integration of philosophy of science and aesthetics, and interdisciplinary work more broadly.

### **3. Methodological lessons for the integration**

One way of interpreting the previous difficulties of including examples or theories from art in accounts in philosophy of science is by pointing out a common methodological issue, or more precisely, a general lack of explicit methodological debate about how and to what purpose discussions about scientific and artistic representation can be integrated. For instance, ‘what is the precise role that

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<sup>8</sup> On the specialization of academic disciplines, and particularly of the branches of philosophy, see: Collins (1998), especially Chapter 12 ‘Intellectuals Take Control of Their Base: The German University Revolution’, and Chapter 13 ‘The Post-Revolutionary Conditions: Boundaries as a Philosophical Puzzles’, and Schaffer (2013).

elements from art are playing in an argument about scientific models?’ and ‘what is the epistemological benefit of combining discussions on scientific and artistic representations?’ We can respond to the first question affirming, for example, that elements from art are mere anecdotes within an argument about scientific models, or that they are particular examples to show parallels between scientific and non-scientific representations, or crucial elements to argue for a general theory of representation that equally describes all types of representations, etc. Making these remarks explicit can avoid ambiguities about the purpose of the integration and function as a guide to reading philosophers’ arguments correctly.

The claim about the lack of explicit methodological discussion surrounding the inclusion of art in accounts in philosophy of science can be taken as part of the broader observation that methodological debates in philosophy of science are scarce. Phyllis Illari (ms.) has observed, after attempting a systematic search for literature on methodological questions in contemporary philosophy of science, that there are very few debates of this kind in peer-reviewed journals, and only occasional comments in books and collections (Illari, ms: 3-4). She is particularly concerned with the argumentative strategies that philosophers of science adopt when they introduce case studies in their accounts: although ‘vigorous methodological preferences are held, the justifications for their preferences are not openly debated’.<sup>9</sup> Her paper is then a call for open debate, since ‘confusion can be eliminated by greater methodological clarity (ms: 23). Specifically her ‘strongest methodological recommendation is that authors more explicitly articulate their aims, including how they choose and use their examples and cases in arguing for their thesis’ (ms: 2).

Illari also noticed that the sub-field of iHPS (Integrated History and Philosophy of Science) is one of the places where most of the existing methodological debates in philosophy of science have occurred (Illari, ms: 7-9). Work in iHPS initiated in the 1960s and was profusely developed in the following

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<sup>9</sup> Illari focuses on literature on causality in philosophy of science. She describes how some philosophers use toy examples, others refer to actual examples in science, and others introduce elaborated case studies to argue for their accounts. Problems arise when they don’t recognise the different scope their respective proposals have. For instance, someone might place disproportionate emphasis on problems with the use of a toy example as if they were put forward as central case studies in actual scientific research (Illari, ms.).

decades.<sup>10</sup> This sub-field draws on the premise that interdisciplinary work is necessary for the advancement of more adequate descriptions of the scientific enterprise. However, integrating two different traditions like history and philosophy raised important methodological issues that needed to be openly addressed. The main issue was, of course, how to gather historical evidence about particular circumstances to justify philosophical claims, which have a universal (and even ahistorical<sup>11</sup>) character; or, vice versa, how to sustain general philosophical claims with reference to singular historical events. The point I would like to stress here, although it would need further characterisation in future work, is that in the last fifty years an open debate about the best methodological approach for iHPS has run in parallel to actual proposals in iHPS. Similarly, running methodological discussions about the integration of philosophy of science and aesthetics could have a positive impact on the endeavour of advancing particular accounts of scientific and artistic representation.

An example of the kind of methodological reflection in iHPS that could be illuminating here is found in Peter Dear's (2012) paper 'Philosophy of science and its historical reconstructions'. Dear (2012: 68) argues that at first sight we could judge iHPS as having a 'single subject matter', namely *science*, which is observed from two perspectives, one historical and one philosophical. If this was strictly the case, the integration of the two fields would happen in a not very problematic way, by combining descriptions from one discipline and the other. Contrary to this, Dear points out that different disciplines have their own problems and their own ways of addressing those problems: 'it is surely not clear that history and philosophy had the same way of doing things; that they saw their common subject matter, science, in the same way, or raised the same questions about it' (Dear, 2012: 68). His own proposal in iHPS is consequently directed to identify, in the first place, the particular underlying questions that historians and philosophers

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<sup>10</sup> The Boston Studies' volume *Integrating History and Philosophy of Science. Problems and Prospects* (Mauskopf and Schmaltz, 2012) offers a good overview of the state of the art of the field of HPS after fifty years of discussions.

<sup>11</sup> Whether philosophical claims have an ahistorical character or not is another point of discussion in iHPS. Authors like Kuukkanen (2015: 1) argue that philosophy and history entail incompatible metaphysics, i.e. essentialist versus historicist metaphysics, while others like Chang (2012) claim that it is possible to conceive philosophy as a historically-engaged endeavour.

ask, and the very specific places where a fertile dialogue between them can take place and where it cannot.<sup>12</sup>

Comparably, it could at first sight appear to us that adding accounts of representation in philosophy of science and aesthetics could give us a more complete view of the same subject matter. And this is probably correct to a certain extent, but only as long as there is awareness of the underlying worries that distinguish the debate in each of these fields. Having a common subject matter (the problem of representation) might sometimes obscure the fact that motivations for addressing that matter can vary in substantial ways. For instance, philosophers in aesthetics usually identify the problem of representation with the problem of depiction, and they predominantly focus on the analysis of how we perceive pictures (Kulvicki, 2006: 535). Meanwhile, philosophers of science have been interested in how representations of many kinds – images, graphs, diagrams – are used to present data, reason with it and lead to new discovery: they have mostly advanced nonperceptual accounts of representation (Kulvicki, 2006: 536). Another example is the historical burden that the notion of ‘similarity’ respectively carries in aesthetics and philosophy of science, being heavier and longer in the former case than in the latter.<sup>13</sup> This generally implies that accounts of similarity in aesthetics tend to be sharper and more historically sensitive than in philosophy of science, where total rejection or complete endorsement seem to be the only possibilities towards the assessment of the role of similarity in representation.

At the end, there might be some irreconcilable differences between certain questions posed by philosophers of science and aestheticians. But in principle that does not invalidate the project of establishing fertile conversations between them. Much more important is to note that it is at the level of the fundamental underlying concerns where the most relevant commonalities between aesthetics and philosophy of science lie. Kulvicki has affirmed that the divergences between philosophy of science and aesthetics actually justify the attempts of dialogue

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<sup>12</sup> Dear proposes the concept of ‘epistemography’ to his purpose: ‘I suggested that the core of [history, philosophy and social studies of science] should be seen as ‘epistemography’ – the attempt to give an empirical account of knowledge-practices. This seems to be a useful pragmatic stance to take, even despite the obvious objection that one person’s empirical account might be somebody else’s distorted misrepresentation’ (Dear, 2012: 71).

<sup>13</sup> See Halliwell’s *The Aesthetics of Mimesis: Ancient Texts and Modern Problems* (2002) for a historical enquiry about the origins and development of the prejudices surrounding the notions of mimesis and similarity.

about representation (Kulvicki, 2006: 536). I would add that the acknowledgement of those divergences is in itself necessary to make the dialogue fruitful. Remarkably, Kulvicki sees the benefits of the dialogue for aestheticians as well, who could develop better tools to study the phenomenon of depicting by adopting the more embracing and cognitive notion of representation that philosophers of science use (Kulvicki, 2006: 536).

Before concluding, I would like to briefly refer to two recent accounts of representation, in which the positive fruits of the integration of aesthetics and philosophy of science are especially visible, namely Bas C. van Fraassen's and Catherine Elgin's latest proposals. In these cases, the integration of elements in art and science is done in a methodologically systematic way, with clarity about the epistemic benefit of the integration and taking into consideration the singularities and concerns existing in each field.

Bas C. van Fraassen's (2008) *Scientific Representation: Paradoxes of Perspective* is one of the most comprehensive efforts to explain the problem of scientific representation in recent philosophy of science. It is, in addition, an effective attempt to connect scientific, artistic and other types of everyday representations, such as maps and caricatures. One central element in the book is the beautifully reconstructed history of the concept of 'perspective', that van Fraassen describes as thoroughly entangled in painting, geometry and technology since the Renaissance (van Fraassen, 2008: 60). The concept of perspective is introduced not merely as a metaphor or a synonym of 'point of view', but recalling the literal meaning of perspective as a 'measurement technique', in the way Leon Battista Alberti (1435) and Albrecht Dürer (1525) originally used it (van Fraassen, 2008: 8). The most important features of drawing in perspective in this view are: occlusion, systematic distortion, orientation, grain and indexical judgment (van Fraassen, 2008: 85). Van Fraassen characterises each of these features, alluding to more contemporary discussions in aesthetics, such as Erwin Panofsky's (1945) and Martin Kemp's (1991) accounts of perspective<sup>14</sup>, John Hyman's (2000) and Dominic Lopes' (1996) ideas

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<sup>14</sup> Van Fraassen refers to Albrecht Dürer's treatise *Unterweysung der Messung* ('Art of Measurement') through Erwin Panofsky (Panofsky (1945) *Albrecht Dürer*. Princeton University Press); and to Leon Battista Alberti's *De Pictura* (1435, "On Painting") through Martin Kemp's introduction to Alberti (1991) *On Painting*. London: Penguin Books.



on the role of occlusion in pictures and Robert Hopkins' (1998) notion of misrepresentation<sup>15</sup> (van Fraassen, 2008: 37).

After the detailed reconstruction of the concept, drawing on the history of art and analytic aesthetics, van Fraassen exposes the ultimate goal of his argument: to demonstrate that representing in science is also an 'art of drawing in perspective'. Moreover, occlusion, distortion and the other distinctive features of perspectival pictures are equally essential to scientific representations, even in the cases of mathematical models and other highly abstract representations. 'Descartes's analytic geometry, Newton's and Leibniz's differential and integral calculus [...] provide, on an abstract level, resources for representation so perfect that they tend to engender oblivion to the distortions on which they trade' (van Fraassen, 2008: 41). But, as with any picture drawn in perspective, these abstract representations do enclose specific distortions of their components, occlusion of many elements that are not included in the representation, selection of a particular grain (coarse or fine) and, even more importantly for van Fraassen, indications about indexical judgments that would allow us to locate ourselves in relation to the representation (van Fraassen, 2008: 66–76). In a nutshell, the careful analysis of the notion of perspective in the history of art is used by van Fraassen to disclose aspects of scientific representations that would have been otherwise overlooked. He succeeds in showing common practices of science and art, such as the activities of selecting, occluding and distorting that take place in the process of representing in the two domains.

The second proposal I would like to refer to is Catherine Elgin's latest work (2004, 2010, 2011, 2017) that develops on the tradition set by Nelson Goodman (1968). A crucial assumption underlying Goodman's and Elgin's work is that science and art share important means and goals, and derived from there, that philosophy of art as much as philosophy of science should be an integral part of the discipline of epistemology (Goodman and Elgin, 1988). In comparison to most of the approaches I have mentioned in this paper, in which concepts from art are brought into the debate in philosophy of science, the methodological postulate in this case is different: the resources of epistemology should be able to account for the cognitive achievements of both scientific and artistic representations. This idea is challenging in at least two ways. First, it demands a

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<sup>15</sup> See: Hyman, J. (2000) "Pictorial Art and Visual Experience", *British Journal of Aesthetics*, 40; Lopes, D. (1996) *Understanding Pictures*. Oxford: Clarendon Press, 1996; and Hopkins, R. (1998) *Picture, Image and Experience*. Cambridge University Press.

more flexible conception of the boundaries of epistemology. Elgin has repeatedly argued that the scope of epistemology needs to be broadened, because it is too strongly supported on a notion of 'knowledge' – as justified, true belief – that cannot explain the innumerable representations that afford epistemic access to the world without being literally true (Elgin, 1996: ix). Understanding rather than knowledge should be the object of epistemologists' concerns. And second, this idea equates the cognitive value of scientific and artistic representations. In the paper included in this volume, Elgin concludes that 'the difference between the arts and the sciences is more practical than epistemic' (this volume: 40). Works of art can be epistemically rewarding as they reorient us, enabling us to see things in the extra-aesthetic world differently from the ways we saw them before. And this is not that different from what an experiment or a thought experiment in science can do (this volume: 35). Fiction, exemplification, metaphor and depiction are means in the production of artworks, but also in the production of scientific models. The consequence of this, putting it in Goodman's words, is that 'the arts must be taken no less seriously than the sciences as modes of discovery, creation, and enlargement of knowledge in the broad sense of advancement of the understanding' (Goodman, 1968: 102).

Two different methodological lessons can be extracted from the works just described. Van Fraassen's proposal is an effective attempt to incorporate elements from art into the debate of scientific representation. It demonstrates that the dialogue with aesthetics and the history of art can be beneficial for the understanding of scientific representations, insofar as it is done in a systematic way, respectful of the tradition of debates that is characteristic of each discipline. Goodman and Elgin go one step further. Their proposals show more profound epistemic and cognitive links between science and art than probably any other contemporary attempt to connect the two domains. A specific methodological approach is present here: the problem of representation must be discussed within the domain of epistemology. Moreover, epistemology, as a normative discipline, should be able to account for the varied – and often non-verbal – means through which scientific and artistic representations succeed in affording understanding about the world. These proposals exemplify two ways of bringing philosophy of science and aesthetics together, and show that the problem of representation can be more fruitfully addressed in the intersection of the two domains. But they also show that a well-reasoned methodological strategy and explicit epistemic goals are required to justify an interdisciplinary approach of this kind.

#### 4. Concluding remarks

In their introduction to the volume *Beyond Mimesis and Convention: Representation in Art and Science* (2010), Roman Frigg and Matthew Hunter defended the positive effects of a more thorough dialogue between philosophers of science and aestheticians. They described the way in which philosophers in each field feel the need to incorporate resources from the other field as inevitable ‘covert acts of kleptomania’ (Frigg and Hunter, 2010: xvi). I believe this expression captures the unavoidable act of recognizing the strengths and potential of other domains to address particularly complex problems like representation. Still, I hope to have shown why thinking in terms like ‘kleptomania’ is probably not the most adequate way of addressing the integration of philosophy of science and aesthetics. Stealing resources and concepts from other fields typically involves the misuse of the original ones. If our acts of incorporating elements from other traditions of thought are, instead of ‘covert’, explicit, noticeable, openly problematised, the results would possibly be more fruitful and precise in methodological terms.

I tried to summarize, in section 2 of this paper, various attempts in contemporary philosophy of science to incorporate elements from pictorial arts into accounts of scientific representation (Suárez, 2003; Chakravartty, 2010; French, 2003). Although these works have advanced significant considerations to the problem of representation and highlighted relevant commonalities between scientific and artistic products, some limitations concerning the precise role of artistic elements in their accounts were pointed out. In section 3, I offered some general methodological comments on the project of integrating aesthetics and philosophy of science, specifically taking reflections in iHPS on interdisciplinarity as an inspiring example for it. The argument here needs to be further developed, but two recent proposals from van Fraassen (2008) and Elgin (2010, 2011, 2017) were presented as examples of particularly insightful ways of connecting scientific and artistic representations.

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