True Griceanism: Filling the Gaps in Callender and Cohen's Account of Scientific Representation

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Callender and Cohen have proposed to apply a "Gricean strategy" to the constitution problem of scientific representation. They suggest that scientific representation can be reduced to stipulation by epistemic agents. This account has been criticized for not making a distinction between symbolic and epistemic representation and not taking into account the communal aspects of representation. These criticisms would not apply if Grice's actual strategy were properly employed. I transpose Grice's strategy to epistemic representation. The main novelty of the resulting account is a distinction between contextual representational use and general representational status, which I address using the notion of indexicality.

1. The Gricean Account of Scientific Representation. Is there a special problem of scientific representation? Several authors have been discussing, for decades now, various hypotheses about what constitutes scientific representation, what distinguishes scientific representation from other types of representation, and other related issues. But according to Callender and Cohen (2006), these debates, although somehow informative, should be reframed, because there is no special problem with scientific representation.

They argue for this thesis on the basis of a strategy that they call General Griceanism, taking inspiration from Grice's work in philosophy of language. Grice proposed a reductive account of the meaning of linguistic utterances in terms of mental states and suggested that "nonnatural meaning" (including linguistic meaning) derives, in a sense that will be detailed later, from "natural meaning," the kind of meaning involved in sentences such as "dark clouds mean that it will rain."

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Callender and Cohen identify two stages in this strategy. The first one, according to them, is "relatively trivial" and consists in "trading one problem for another" by explaining the representational powers of derivative representations in terms of those of fundamental representations. The second stage consists in explaining representation for the fundamental bearers of content. They suggest that the same general strategy could be applied to scientific representation, to the effect that representation in science would be derivative of mental representation and that the question of what constitutes representation could ultimately be delegated to the philosophy of mind. They claim, more specifically, that "representation is constituted in terms of stipulation (plus an underlying account of representation for the mental states subserving stipulation)" (Callender and Cohen 2006, 77 n. 7).

Their proposal entails that all the particular characteristics of vehicles of representation in science, perhaps their similarity with their targets, for instance, would not *constitute* the representation relation between the vehicle and the target. They would be a mere matter of pragmatics. That is to say, these characteristics would not correspond to constraints on what counts as a scientific representation (for this, stipulation by scientists is enough) but rather to features that are generally considered desirable for the purposes of the scientific community. In this respect, most of the debates about scientific representation in which philosophers had been engaged (at least until the publication of their article) might have been informative, but they were badly framed because they were really about pragmatic issues. As an example, the problem of demarcation between scientific and nonscientific representation would be a problem of demarcating different practices, and as such, it would be an instance of the more general demarcation problem between science and nonscience.

This is a very interesting proposal, but I think it is underdeveloped as it stands. My aim in this article is to provide a better Gricean account of scientific representation by looking more closely at Grice's reductive strategy.

Callender and Cohen's approach has been criticized by many authors (Toon 2010; Bueno and French 2011; Peschard 2011; Ducheyne 2012; Frigg and Nguyen 2017). In this article, I focus on two main criticisms, which are to my knowledge the most developed in the literature and which happen to be complementary: Liu (2015) and Boesch (2017). The first one emphasizes the difference between symbolic and epistemic representation, and the second one the communal aspect of scientific representation. In section 2, I present these criticisms and argue that they only apply to a simplistic understanding of Grice's reductive strategy (which can be partly imputed to Callender and Cohen). In section 3, I present Grice's actual strategy for reducing linguistic meaning to mental states. In section 4, I attempt to fill the gaps left open by Callender and Cohen's proposal, by conscientiously applying Grice's strategy and heuristic method to epistemic representation. The

resulting account explains how epistemic representation derives (in a nontrivial way) from symbolic representation and reduces to mental representation. I refine the account in the face of objections in section 5 and introduce an important distinction between contextual representational use and general representational status. Finally in section 6, I give a few comments on the prospect of deriving scientific representation in particular from epistemic representation in general and argue that this is, indeed, a mere problem of pragmatics.

2. Criticisms of the Gricean Strategy. Liu (2015) claims that Callender and Cohen's reductive account of scientific representation in terms of mere stipulation by the agent fails to make an important distinction between symbolic and epistemic representation. The distinction is not a matter of pragmatic difference between the vehicles used and whether they are good for particular purposes but a more fundamental difference in function: in symbolic representation (e.g., with a stop sign or the logo of an airline), the connection between the vehicle and the target is purely conventional, and the role of the vehicle is simply to invoke a mental state among interlocutors or to pick out its referent without giving us any information about the referent. Any resemblance between the vehicle and the target is a matter of pragmatics, since it is not essential to the realization of this function. This is not so with epistemic representation: the connection between, say, a scientific model or a map and its target is not purely conventional, even when conventions are used. This is because the function of epistemic representations is to "allow their users to have access, in however simplified or specialized manners, to aspects of their targets, which fulfil, in a broad sense, an epistemic role" (47). When used in communication, this function is not to invoke belief states but to *create* them. In other words, we can learn what the target is like from an epistemic representation. This function cannot be realized by mere conventional stipulation. And it is not a matter of pragmatic utility but an essential feature of epistemic representations: it constitutes the representation relation in science.

According to Liu, these key differences are reflected in the fact that epistemic vehicles *contain* symbols, organized, for example, in a mathematical structure, while basic symbols do not need to contain other symbols: they are sufficient in themselves. This is precisely because the way symbols are selected and organized in an epistemic representation is not conventional but serves an epistemic function. So while epistemic representation does use symbols for denotation, which helps secure the relation to the target, it is not itself symbolic.

Boesch's criticism is focused on the fact that scientific activity involves communal aspects. Scientific representation cannot be reduced to mental representation, because the latter is private and not constrained in the same way by the community. Taking the example of reminiscence, by which a vehicle

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is capable of inducing thoughts in an agent (e.g., "a drawing can be reminiscent of my nephew"; Boesch 2017, 972), he observes that relations of reminiscence can be reduced to mental states, that they can be created by mere stipulation, and that in this case, any resemblance between the vehicle and its target is merely pragmatic. Furthermore, different agents can disagree about whether an object is reminiscent of another without any of them being wrong.

What a scientific model represents, in contrast, is independent of a mere stipulation by any particular scientist but depends on licensing by the community. Taking the example of the Lotka-Volterra model, Boesch argues that in order to know what a model represents, one has to examine its history: how and why it was constructed, how it was received by the scientific community, and how it is currently used. This examination reveals that mere stipulation is not sufficient for a model to be licensed as a representation of something else. In particular, it reveals, in the case of the Lotka-Volterra model, that "the construction of the model . . . has been responsive to certain theoretical and empirical aims" (Boesch 2017, 976). According to Boesch, this licensing aspect is not a mere pragmatic limitation on how some already existing representations should be used, but it actually constitutes the representation relation itself: the model is a scientific representation of its target because it has been carefully constructed to function as such, taking into account empirical and theoretical aspects.

Note that some of Boesch's remarks are also true of symbolic representation: a dove represents peace in a way that is independent of the stipulation of any agent, and to understand what the dove represents, one can have a look at the history of the symbol. Stipulation can also be communal. So "licensing" does not seem to be specific to epistemic representation, let alone scientific representation (I guess he would agree with this, since he employs examples from art). At most the nature of this licensing in science, in particular its nonarbitrariness and its responsiveness to empirical and theoretical aims, is specific, and this rejoins, to some extent, Liu's distinction between epistemic and symbolic representation. Yet the idea that Callender and Cohen fail to account for communal aspects in general, that these aspects are not reducible to mental states and that they are constitutive of the representation relation, remains a complementary objection, and this is the objection I will focus on in this article.

Although these criticisms make interesting observations about how representation works in science, I think both rest on a simplistic understanding of Grice's reductive strategy. Callender and Cohen can be held partly responsible for this, and Liu's and Boesch's criticisms probably apply to their account, but they would not apply to a proper transposition of Grice's ideas to scientific representation.

First, Grice proposes a derivative account of nonnatural meaning in terms of natural meaning. But a derivation is not a reduction: according to Grice, natural and nonnatural meanings are clearly distinct, nonoverlapping concepts.

Grice's derivation is a means of exhibiting the conceptual links between the two concepts, as will be explained later. In this respect, Callender and Cohen's claim that Grice gives a "reductive account of non-natural representation in terms of natural representation" (2006, 72) is incorrect. Admittedly, the resulting account reduces nonnatural meaning to *mental states* (in particular, intentions to produce belief states). But reduction is not identification, and Grice's account is rather subtle.

Acknowledging this, one could maintain that epistemic representation derives from symbolic representation, while agreeing with Liu that they are distinct in important respects. Liu actually provides some insights that could be relevant for such a derivation, such as the fact that epistemic representations use symbols. Toon (2010) makes a similar point, observing that Callender and Cohen's reduction of representation to mental states takes a very simple form. More sophisticated accounts could be proposed (and Toon's "models as make-believe" purports to be such a proposal).

Second, Grice's reduction to mental states concerns the meaning of particular utterances, which is distinct from the meaning of words and expressions outside of a context of utterance. He has another story to tell about this. For sure, both are related, but they are distinct: utterance meaning has to do with a particular speaker's intention to transmit a belief, while expression meaning concerns the appropriate or optimal use of expressions in particular utterances. The latter can be perfectly "communal," and Grice explicitly says that he does not think that this is a mere matter of convention. Using communal norms of appropriateness for better communication in a particular context might be a pragmatic issue, and these norms are not constitutive of utterance meaning, but they are constitutive of expression meaning. (This part of Grice's strategy is not mentioned by Callender and Cohen.)

By analogy, one could distinguish the use of scientific models by particular users in particular contexts and the communal "standard use" or representational status of these models. The latter would have to do with "licensing" norms and would have a less direct link to mental states. It need not be merely conventional. This kind of view is fully compatible with Boesch's remarks. This means that the Gricean strategy can indeed be applied to scientific representation, so as to delegate the constitution problem to philosophy of mind when it comes to contextual uses and to a problem of communal values when it comes to the general representational status of a model.

This distinction between contextual use and general status might be a blind spot of most accounts of representation proposed so far, and confusion between the two might be the source of unnecessary difficulties. I have not seen the distinction made explicitly in the literature,[1] and it is not always clear to

1. Except perhaps for Chakravartty (2010, 209 n. 10) differentiating "the issue of what a representation is, as a means, and the issue of how representations are used."

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me whether philosophers discussing scientific representation are talking about one aspect or the other: what a vehicle represents for a user in a particular context or in general. But there is no reason to identify the two: the model of the hydrogen atom can represent one particular atom in an experimental context, but it does not represent this atom in general, so there is a clear difference between these two representational statuses. In this respect, Grice's strategy promises to bring important distinctions that have been neglected so far and that could shed light on some controversies.

Having said that, the task of providing a Gricean account of scientific representation might not be as trivial as Calendar and Cohen claim. This article is an attempt to fill the gaps in their proposal, by showing how scientific representation can be derived from symbolic representation (so as to exhibit their conceptual links) and, ultimately, reduced to mental representation and communal values.

3. Grice's Actual Strategy. Let me first present Grice's account of meaning in more detail. I focus on the account as presented in "Meaning Revisited" (Grice 1989, chap. 18). In this comprehensive article, Grice offers a narrative, the purpose of which is to show how to go from natural meaning to nonnatural meaning.

Natural meaning is the sense of "mean" used in sentences such as "these black clouds mean that it will rain" or "the spots on your face mean that you have measles." It can be understood as a relation of consequence or entailment between the sign and its target. Nonnatural meaning is the sense used in sentences such as "his gesture meant that he was fed up." A criterion of demarcation between the two, which shows that they do not overlap, is that natural meaning is factive, while nonnatural meaning is not: "these black clouds mean that it will rain" is false if it will not rain, but one's gesture can mean that one is fed up even if this is not actually the case.

Grice purports to show that these two senses of meaning are related, in the sense that nonnatural meaning derives from, or is a "descendant" of, natural meaning. This is done by presenting six stages with which one can progressively go from a situation in which natural meaning is involved to a situation in which nonnatural meaning is involved.

Let us start from an instance of natural meaning: someone groans nonvoluntarily, which means (indicates) that she is in pain. In the first stage, let us modify the situation slightly and imagine that this person X groans voluntarily in order to get Y to believe that she is in pain. The aim of X could be to deceive Y. In the second stage, let us imagine that Y recognizes that X groans voluntarily, thus undermining the conclusion that X really is in pain. How will we restore this conclusion? In the third stage, we can imagine that X intends that Y recognizes that she is groaning voluntarily, and Y recognizes it. Here we have transparency of intentions, so there is no more deception. But

one could wonder what the objective of this act is. In the fourth stage, from the fact that X is simulating pain without attempting to hide this fact, Y comes to the conclusion that X is inviting Y to contribute to a game of make-believe. But how Y should play this game remains unclear. In the fifth stage, Y recognizes that X is not engaged in play but is simulating a natural sign in order to get Y to believe what this sign would naturally mean: that she is in pain. Furthermore, by being transparent about her intention, X wants Y to recognize that her intention to communicate this is sufficient reason to believe that she is in pain. At this point, one could wonder why X needs to produce a fake expression of pain if she really is in pain. This could be, for example, because there is a looser connection between the sign and the state of affairs that it indicates than in the natural case (perhaps the pain is less intense). This leads us to the sixth stage, where the connection between the sign and what it indicates is relaxed: the sign does not have to resemble a natural sign anymore, thus allowing for more expressive freedom. The connection could rest on a previous stipulation, and the sign can be arbitrary. All that matters is that cooperation takes place and that Y recognizes what the sign means. We have a full act of communication: by producing the sign, X means that she is in pain.

It is important to note that these six stages do not pretend to be a historical or genetic account of nonnatural meaning but rather a "myth designed to exhibit the conceptual links between natural and non-natural meaning" (Grice 1989, 296–97; by analogy with such myths as social contract in political philosophy). We can understand this conceptual link as follows: nonnatural signs artificially reproduce the main function of natural signs, which is to indicate states of affairs, and the narrative exhibits the mental states that are required to achieve this.

This results in Grice's account of nonnatural meaning. A specific utterance *U* means that *p* if, and only if, in performing it, the utterer intends (*a*) that an audience will come to believe that *p*, (*b*) that this audience will recognize intention *a*, and (*c*) that the recognition in *b* will cause the belief that *p*. These are, roughly, the elements that were added at each stage of the narrative.[2]

Note that Grice does not want to restrict himself to symbolic representation. He mentions, in the same article, the use of combinatory devices in languages to communicate. But this raises a difficulty: his reduction seems restricted to full utterances. How will we understand the meaning of the words that constitute these utterances and that can occur in several utterances, and

2. Note that this account has been criticized, with counterexamples involving cases in which the utterer already knows that the audience believes that *p*, such as confessions, or cases in which there is no audience, such as uses of language in thought. However, Grice's specific account of linguistic meaning will not affect the developments of this article.

relatedly, how will we understand the meaning of expressions outside of a context, that is, combinations of words, independently of their possible utterances?

Grice sketches an answer to these questions at the end of the article (he also has a more detailed account of expression forming in terms of "procedures"; Grice 1968). The key is to introduce social values: some uses of words are appropriate, or optimal, while others are not. According to Grice, what a word means in a language is "what it is in general optimal for speakers of that language to do with that word, or what use they are to make of it" (1989, 299). The reasons for optimality could be various: they could have to do with widespread or more local conventions, for example. However, conventions are only one way of achieving optimality. Grice "[does] not think that meaning is essentially connected with conventions" (298). What is essential, according to him, is only the connection with values concerning the appropriate use of words: "what particular intentions on particular occasions it is proper for them to have, or optimal for them to have" (299).

This proposal is, in a sense, a reduction of expression and word meaning to utterance meaning, since the latter is expressed in terms of the former but not the other way around. However, irreducible social values are involved, so there is room for a robust notion of expression meaning at a communal level.

We can see that Grice's reductive strategy is not as simplistic as Callender and Cohen's version. It could have enough resources to respond to worries of the kind raised by Liu and Boesch. However, this is not an account of scientific representation but of linguistic representation. It is often argued, since the rise of the semantic conception of theories, that scientific representation is not linguistic: it is representation by means of abstract entities, such as mathematical structures.

Assuming this, how could we achieve Cohen and Callender's project and give a reductive account of scientific or epistemic representation using Grice's strategy? Let us take for granted that there is something like symbolic representation that reduces to mental states. Let us also agree with Liu that symbolic and epistemic representation are markedly distinct and nonoverlapping. The idea could be to derive epistemic representation from symbolic representation by providing a staged narrative similar to Grice's, taking symbolic representation to be the "ancestor" of epistemic representation (in doing so, we are applying not only Grice's general strategy but also Grice's heuristic method). Hopefully, this narrative will exhibit the main constituents of epistemic representation, which will be exactly the elements needed to go from the first to the last stage.

4. Applying the Strategy to Epistemic Representation. A typical example of an epistemic vehicle is a map. A map is not merely a symbol: it can be

used to navigate a city. The fact that a map represents a given city is not merely stipulated by its user. The way it should be interpreted is communal.

An example of a symbol inducing a mental state is a "turn left" sign, constituted of an arrow suitably oriented. Such sign (normally) induces in the audience the intention to turn left. The connection between the sign and the action is purely conventional: the role of the sign is not to tell us what the resulting action looks like, although for obvious pragmatic reasons, the orientation of the sign and action match.

Let us use these examples. What I suggest is providing a narrative, similar to Grice's, in which one goes from a situation in which a "turn left" symbol is used to a situation in which a map is used (which, of course, does not pretend to be a historical account of how maps were invented):

Initial Situation. Our initial situation is one in which X wants Y to turn left, so X shows a "turn left" sign. The sign merely induces an intention in Y.

Stage 1. In the first stage, imagine that X wants Y to perform a more complex action, such as going from one place to another in the city. Instead of showing one sign, X will successively show various "turn left," "turn right," and "straight ahead" signs at every intersection.

Stage 2. In the second stage, imagine that Y asks X to tell her how to go from one place to another, and X responds by showing the appropriate signs at each intersection. Y assumes that X is not being deceptive, or at least she pretends to, and follows the instructions.

Stage 3. In the third stage, instead of showing the signs, X hands Y a sheet of paper on which a succession of symbols are represented and explains to Y that they should be followed successively at every intersection.

Stage 4. In the fourth stage, X has a collection of sheets of paper, each containing the instructions to go from one point to another in the city. The sheets are labeled with new symbols referring to possible start and end points. Y tells X from where to where she wants to go, and X hands her the appropriate sheet. This collection of sheets of paper is not yet a map of the city in the usual sense but rather a collection of routes (although it is a map in one sense of the word: a mapping from purposes to instructions).

Stage 5. In the fifth stage, X realizes that the sheets contain redundant information. For example, going from the post office to the train station requires passing by the city hall, and going from the post office to the library does as well, so the two corresponding sheets start with the exact same list of symbols. There are also interesting relations between the list of symbols for going from

A to B and that for going from B to A: their order and orientations are reversed. So the representation can be simplified.

- X first adds new symbols that do not refer to departure or destination points but to intersections (steps in instruction sheets) and expresses each path as a sequence of crossed intersections.
- On a sheet of paper, X represents intersections by points that are connected by a line when they are next to each other in a sequence.
- When intersections A, B, and C follow in a sequence, X encodes the action required at B to go from A to C in the form of an angle between the lines AB and BC (so that, when going from C to A, the angle is reversed). Intersections can be identified when they coincide geometrically, without loss of information. This results in factorizing all paths in a single representation.
- Y tells X where she wants to go, and X computes the instructions from the representation, reproduces them on a sheet, and hands it to Y.

Stage 6. In the sixth stage, instead of handing navigating instructions to Y, X displays the representation of all paths in a public place, with detailed explanations on how to extract specific instructions. Y does not need to tell X from where to where she wants to go: she computes her instructions herself.

The resulting representation is exactly what we would call a map of the city, with points of interests and paths between them. Y can use the map to make inferences on how to travel between any two points in the city. We have a full epistemic representation.

The following items were required to go from symbolic to epistemic representation:

a) The vehicle is capable of inducing complex sequences of mental states on its user (introduced at stage 1).
b) The user is confident, or pretends to be confident, that the induced mental states are suitable for achieving particular purposes (stage 2).
c) Clause *b* holds not only for one purpose but for a variety of related purposes within a range, from which the user can choose (stage 4).
d) The mental states in *a* are not induced directly but encoded in a minimal structure and can be retrieved systematically by following interpretative rules (stage 5).

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e) Users can induce the mental states autonomously by following the rules adapted to their purpose (stages 3 and 6).

We will say that a vehicle is used as an epistemic representation if, and only if, all these characteristics are fulfilled. This is a Gricean reduction of epistemic representation to mental states, in particular, to attitudes toward the reliability of the vehicle for achieving various purposes and to symbolic representation (including possibly complex interpretation rules, which, I assume, reduce to mental representation in the same way symbolic representation does).

Let us go back to the constitution question and to Liu's worry that a Gricean account would not distinguish between epistemic and symbolic representation: What makes the vehicle a representation of its target? In our case, What makes the map a representation of the city? Contrary to symbolic representation, the vehicle does not merely pick out an object or invoke a belief. It is constituted of symbols organized in such a way that the vehicle can support the application of rules and fulfill its function (reliably or not), which is to allow navigation in the city. The map does not merely invoke a mental state, but it *creates* mental states with the help of interpretation rules. The user assumes, or pretends, that it is a reliable means of navigating the city, which could not be obtained by mere stipulation. And all this is a constitutive aspect of the representation: it is, according to this account, in virtue of these aspects that the map is an epistemic representation of the city. This makes epistemic representations markedly distinct from symbolic ones, in a way that corresponds to Liu's remarks.

Having said that, the connection between the vehicle and the target is not as strong in this account as Liu might expect: it is enough that the user pretends that the vehicle is reliable for a set of purposes for it to be an epistemic representation. The key difference with Liu's characterization of epistemic representation is that reliability is not assumed: only the attitude of the user toward reliability is required. I think this is an advantage of the current account, since it makes misrepresentation possible, and the vehicle still has a distinctive epistemic function, which is what really matters at this stage. The concerns associated with the idea that the representation relation could still rest on mere stipulation or pretence are related to Boesch's criticisms, and they will be addressed in the next section. Perhaps another aspect invoked by Liu is missing: the idea that the function of the vehicle is to tell us what the target is like. I return to this aspect below.

It is noteworthy that even though the vehicle does not merely pick out a referent, it ends up having a target that is quite well delimited. The key stage is stage 4, where a bounded list of possible purposes is introduced: all these purposes have in common that they concern the city and, more precisely, navigation between two points in the city. The lesson of this, I think, is that

the target of an epistemic representation is better characterized as a range of available purposes than as a specific object. Generally, these purposes will all concern the same object, and then it makes sense to claim that the vehicle is a representation of the object. But one should keep in mind that such representation is always perspectival, in the weak sense that the object is represented relative to a bounded set of possible purposes concerning it. This point is particularly relevant for scientific representation, as it has been observed by many that scientific models are generally idealized and that some aspects of their target are focused on at the expense of others (see, e.g., Mäki 2009; Morrison 2011).

The importance of purposes in representation has already been emphasized elsewhere (Bailer-Jones 2003; Giere 2004) but not as a characterization of the target of representation (with the notable exception of Knuuttila and Boon [2011]). Doing so looks very instrumentalist. One could object, in line with Liu's characterization of epistemic representations, that an epistemic representation should tell us what its target is like, independently of its usefulness for achieving particular purposes: it is because the vehicle tells us what the target is like that one can use it as a basis to achieve various purposes. The content of an epistemic representation must be true or false, not merely good or bad.

In our map narrative, the purposes afforded by the vehicle correspond to performing certain actions, and the vehicle induces corresponding intentions (turning left or right). Admittedly, this gives an instrumental flavor to the account. But note that the resulting conception of epistemic representation, summarized in clauses *a*–*e*, is less specific.

I would tend to think that vehicles intended for mere instrumental uses do count as epistemic representations. After all, saying that a scientific model or a map is true sounds a bit weird in English and other languages, but saying that it is good, or reliable, sounds fine. And even if a representation is primarily instrumental, nothing precludes inquiring about the correspondence between its content and the world. In our narrative, we can imagine that the structure of the map ends up corresponding to the structure of the city as a side effect of its reliability, and we can say that its content is true.

In any case, this does not mean that epistemic representation is restricted to instrumental use: the mental states induced by a vehicle could be belief states rather than intentions, for example, the belief that the target is such and such. The relevant purposes could be knowing what the target is like in such or such respect, or explaining a given phenomenon, rather than performing some action. A similar narrative could probably be given in which signs in the first stage would invoke beliefs rather than intentions, and successive stages would add more complex requests from Y (e.g., replace "turn left" with "there is a street on the left," and interpret the succession of signs as spatial continuity). One could go as far as claiming that beliefs are

ultimately dispositions to form sequences of intentions and that the stimuli for these dispositions are purposes, so that belief states are exactly what an instrumental epistemic vehicle gives us.

So this account is not in principle limited to instrumental vehicles. The reader who disagrees that instrumental representation is genuinely epistemic is free to find a better label for the type of representation addressed here and to claim that genuine epistemic representation is a subtype of this type, where purposes and induced mental states are more markedly epistemic.[3]

5. From Contextual Epistemic Use to General Epistemic Status. So far, we have a reduction of epistemic representation to mental states, encapsulated in clauses *a*–*e* above. But this account is incomplete as it stands. Let us examine two possible objections. They will allow us to introduce the main novelty of our final account, which parallels Grice's distinction between utterance and expression meaning:

Objection 1. This notion of epistemic representation is too dependent on the attitudes of the user. If someone uses a map of Mexico City thinking or pretending it is a map of New York City, this does not turn the vehicle into a map of New York City. (This is similar to Boesch's criticism of Callender and Cohen: mere stipulation is not enough.)

Objection 2. Only concrete vehicles can count as representation in this account. Arguably, abstract entities have no causal power, so they cannot induce mental states. But scientific models are often conceived of as abstract entities, and the equations on paper through which they are used are mere descriptions of these abstract entities. So this account is inadequate.

I am confident that these two objections can find a common solution, which will rest on a distinction analogous to Grice's distinction between expression meaning and utterance meaning.

One thing is to understand how users use vehicles as epistemic representations. Another thing is to ask what the vehicle represents as a matter of generality. The account provided so far is an account of particular uses. I think that someone using a map of Mexico City in New York City is indeed using the vehicle as a representation of New York City and that this use reduces to mental states: in particular, the belief that the vehicle is reliable for navigating

3. Perhaps we could also invoke emotional states and extend this account to artistic representation, although I suspect that, in the case of art, purposes will be tied to the artist and not to the user.

New York City (even when this belief is false, as is the case here). In this respect, this account is not defective.

However, the map is actually a map of Mexico City, even if used in New York City. We can say even more: it would still be a map of Mexico City if it were not used at all. This shows that the status of the vehicle as a representation of something is independent of its actual uses.

We have two senses of representation, one that concerns particular, contextual uses and the other that concerns the status of the vehicle in general. I would like to apply Grice's strategy here and reduce the second sense to the first one by making a detour through values: general representational status should be explained in terms of particular uses and, more precisely, in terms of the optimality of particular uses.

In our example, the map is indeed a map of Mexico City even if used in New York City because the optimal way to use it, according to social values, is to use it as a map of Mexico City. Such use is "licensed," as Boesch would say. This is a communal aspect that could have to do, for example, with the fact that the map was designed to be used in Mexico City and that the provider of the map is recognized as trustworthy among map users.

Boesch is right that in order to know what the map represents in this second sense, the mental states of users are not enough: one has to look at how the map was produced and received and how it is currently used in general. This will reveal that more than conventional stipulation is at stake. If we took our narrative of section 4 as a real story of how a map was produced, we could see that the map was carefully designed to be used for navigating one particular city. It is not by conventional stipulation but by construction that the vehicle becomes a representation of this city. Symbols were not selected and organized arbitrarily but in order to achieve a particular aim. We can also presume that the map will be accepted and used by the community if this aim can be successfully achieved. So both the construction of the model and its acceptance by the community are responsive to empirical aims, not only to conventional aspects. The actual reliability of the representation plays a role at this stage, at least as one criterion of the licensing process. This "licensing" is a social guarantee of optimality. It is a constitutive aspect: it is what makes the map a representation of the city in the second sense of representation. All this does justice to Liu's and Boesch's remarks about scientific representation.

Arguably, this communal aspect is not necessarily missing in Callender and Cohen's account (although they do not mention the aspect of Grice's work exploited here): it is only relegated to a pragmatic issue. And it might be true that whether to follow the norms of optimality in one's community is, for a particular user, a pragmatic issue. But these norms are nonetheless constitutive of the general representational status of vehicles, a notion of representation that is absent from Callender and Cohen's account. My account

does not fall prey to Boesch's and Liu's criticisms of section 2, so long as this general notion of representation is taken into consideration.

This distinction also provides a way to address the second objection, having to do with the fact that my account concerns concrete vehicles and not abstract entities. In the literature on scientific representation, it is often assumed that many representations in science, theoretical models in particular, are abstract entities. The equations or diagrams on paper used by scientists do not constitute the representation: they describe these abstract entities. Otherwise, why would we talk about *the* Lotka-Volterra model or *the* Newtonian model of the solar system, since different marks on paper are actually used? The account provided in the previous section is focused on the use of concrete vehicles for inducing mental states. So it would seem that this account is inadequate.

In response to this concern, we can first observe that various concrete vehicles are capable of inducing exactly the same mental states in order to achieve exactly the same sets of purposes, using similar interpretation rules. For example, a map can be copied, and every copy will share these features. The colors and symbols could change from one vehicle to another, but its function would remain the same. Presumably, all these vehicles will share a common abstract structure of equivalent symbols (symbols having the same interpretation in terms of mental states, functions, or referents).

Furthermore, the fact that a vehicle is "licensed," that it is considered fit for a set of purposes, does not depend on its particularities as a vehicle (the color used, the texture of the paper) but on these shared aspects. The particularities of the concrete vehicle can be relegated to pragmatic aspects. So what is really licensed, hence what really represents the target in the second, general sense of representation, is not the particular vehicle but the abstract structure of symbols that the vehicle instantiates or describes. The idea that epistemic representations are abstract entities is vindicated. At the same time, the connection between concrete vehicles and contextual uses is preserved, which avoids other difficulties with the idea that models are abstract entities, in particular regarding the connection with actual representational practices (Levy 2015).

To sum up, the way a Gricean strategy can respond to Liu's and Boesch's criticisms works in two stages. In the first stage, an account of what makes a *concrete* vehicle an epistemic representation of its target *in a particular context* is given in terms of the mental states of the user, and this account is sufficiently complex to make epistemic representation markedly distinct from symbolic representation, thereby addressing some of Liu's remarks. In the second stage, an account of what makes an *abstract* vehicle a representation of its target *in general* is given in terms of norms of appropriateness, and this is a communal aspect that does not reduce to mere stipulation, or to the mental states of particular users, and that is responsive to empirical aims, thus

responding to Boesch's and Liu's other concerns. Furthermore, this account addresses another issue in the debate on scientific representation: the fact that vehicles of representation are often conceived of as abstract entities, even though concrete entities are used in representational contexts.

Before presenting the resulting account in full detail, let us introduce one more technicality. It concerns the relationship between contextual use and general representational status. Epistemic uses often concern one particular target to which we refer directly in context. In contrast, an abstract symbolic structure cannot refer to contextual entities in full generality. For example, the model of the hydrogen atom can be used to represent one particular atom in an experimental context, but it does not represent any particular atom in general.

I think the best way to account for this aspect is to borrow from philosophy of language the notion of indexicality, as analyzed by Kaplan (1989). Indexical terms like "I" or "now" do not have a referent outside of a context, but according to Kaplan, they have a "character," which is a function from context of locution to content. For example, the character of "I" specifies that it refers to the speaker in context. Expressions containing indexicals also have a character, and their utterances have content.

The interpretative rules and afforded purposes of an abstract symbolic structure could be characterized by such functions. For example, the model represents the salient atom of hydrogen in context; the symbol "O" (the origin of coordinates) refers to the center of mass of the salient atom, and so on. In context, these components acquire concrete referents that can be the object of concrete purposes, and the interpretative rules become applicable. Outside of a context, we can only imagine how these rules would be applied to achieve particular purposes. This is a way of giving a genuine representational status to abstract entities in terms of a "character."

At this point, we can synthesize our final account of epistemic representation:

1. A concrete vehicle *V* is used by *U* with interpretational rules *R* as an epistemic representation for a set of possible purposes *P* (the "target") if and only if:

   - *V* is capable of inducing complex sequences of mental states (intentions or beliefs) in *U*, which can be retrieved systematically by using *R* (clauses *a*, *d*, and *e* of sec. 4), and
   - *U* assumes or pretends that inducing these mental states with adapted rules is a reliable means of achieving any possible purpose within *P* (clauses *b* and *c*).

2. An abstract symbolic structure *S* is an epistemic representation for a set of indexical purposes *P** and indexical rules *R** within a community

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> *K* if and only if it is considered appropriate or optimal for any member *U* of *K*, in any context *C*, to use a vehicle instantiating or describing *S* with rules *R**(*C*) as an epistemic representation for purposes *P**(*C*).

I have argued that this conception does not fall prey to the criticisms of section 2. It also fulfils one of the main desiderata of any account of representation at both levels: the possibility of misrepresentation. This is so because the fact that *U* assumes that the vehicle is reliable does not entail that it is, even less so if *U* only pretends this, and the same goes for the fact that the representation is considered optimal within a community (although reliability does play a role at this stage, perfect reliability is not necessarily a condition for being licensed by the community). This account is consistent with many aspects recently emphasized in the literature on scientific representation, notably the role of users, purposes, communal norms, and contexts. It has the unique virtue of making explicit the articulation between all these aspects.

6. From Epistemic to Scientific Representation. Scientific vehicles, such as theoretical models, are epistemic vehicles, but do they have particularities that make them distinctively scientific? Callender and Cohen think that this question boils down to the pragmatic problem of delimiting scientific activity.

I have mentioned various criticisms of this idea, to the effect that some aspects would be constitutive of scientific representation rather than merely pragmatic. However, all these specificities apparently concern the fact that scientific representation is epistemic. Since we now have an account of epistemic representation, it is not clear that the particularities of science will be anything more than pragmatic features: whichever epistemic vehicles are found useful or appropriate by the scientific community. One reason to think that this is the case is that there is a wide variety of representational devices in science (equations, diagrams, images, etc.) across very different disciplines (economics, biology, physics). These representational devices do not seem to have much in common, apart from the fact that they are epistemic. Another reason is that many types of representational devices used in science, such as maps and diagrams, are also used outside of science, so that the prospect of a clear demarcation seems moot.

One characteristic of scientific models is that they are often unified in a theoretical framework. But this is not always the case, and models have relative autonomy from theories (Morgan and Morrison 1999). In any case, the theoretical framework could be understood as part of the communal prescriptions for "optimality," constraining the licensing of particular vehicles: in order to model this type of phenomenon, one should use this type of model. This could be explained further in terms of the communal epistemic values of science, in particular, theoretical unification.

We could also characterize science by its hypothetical nature. Scientific models often function as hypotheses to explain phenomena. In the map narrative of section 4, the mental states induced by the representation ("turn left" or "turn right") are entirely controlled by the producer of the map, who seems to know the city perfectly well: no hypothesis is involved. But this is an artifact of the narrative that is not required by the final account. Insofar as the mental states induced by the representation are not merely listed in the vehicle but encoded in a minimal structure (as per clause *d* of the account), the idea that the producer herself could infer something new from her representation, and take it as hypothetical rather than certain, is not precluded. For example, the producer of a map could observe that paths form part of a grid pattern and encode this idea in the map, which will result in hypothesizing new paths in the city. She could pretend that the hypothesis is true and that the new map is reliable for the sake of an experimental test, thus satisfying clause *b*.

The account of epistemic representation provided at the end of section 5 applies quite well to scientific models. Take, for instance, the case of a scientist using a Newtonian model of the solar system. The concrete model is constituted of equations on a paper. The user is capable of inducing sequences of mental states, for example, beliefs concerning various aspects of the solar system, using mathematical rules. She assumes that this is a reliable means of achieving certain purposes, such as knowing the position of Venus in the sky. Finally, this kind of use is licensed by the community: this is a proper way of using the Newtonian model of the solar system.

I think that the narrative provided in section 4 could be reproduced to some extent with examples like this (where the symbols "turn left" and "turn right" would be replaced by numeric symbols interpreted as, e.g., "point your telescope in direction x at time t"). After all, simple predictive models in physics, specifying dynamical transitions between initial and final states, are analogous to maps specifying paths between starting points and destinations. This analogy is developed by van Fraassen (2008), notably with his discussion of self-location (75–82) and of measurement as location in the logical space of a model (chap. 7). Of course, the interpretation of symbols in operational terms, which is required to "locate" physical objects in a logical space and to assess the model adequacy, is much more sophisticated in the case of scientific models than in the case of city maps. This interpretation is often mediated by auxiliary theories or by models of experiments, for instance. But this does not affect the essence of the representation, only the complexity of the rules involved.

One could object that there is more structure in a scientific model than what is required by the narrative proposed in section 4, so maybe a scientific model is more than just a reliable guide to achieve a set of purposes. We can address this objection by looking at Kepler's laws of planetary motion. Do

they merely synthesize the observable trajectories of known planets? Could we really start from a situation in which symbols corresponding to "point your telescope in direction x" are used to a situation in which the laws of Kepler are presented, simply by incorporating various possible purposes and synthesizing corresponding instructions?

One aspect of the issue is that Kepler's laws were not constructed by mere synthesis of observed trajectories, contrarily to what the map narrative of section 4 could suggest. They were more probably the result of an inference to the best explanation. However, this narrative is not an account of how epistemic representations are actually constructed, so this is not a problem.

A more serious problem is that Kepler's laws contain more than a synthesis of observable trajectories. They are more general, because they relate (among other things) the distance from the sun and the orbital period of any planet, including counterfactual ones. The laws do not specify a particular value for the distance of the planet from the sun, so they would apply to a counterfactual planet. But this aspect can be accounted for by considering that Kepler's laws merely enlarge the set of afforded purposes, from knowing the position of one of the known planets at any time (which is what a model like Copernicus's affords) to knowing the position of any planet that would be salient in any possible context, including nonactual contexts. This entails that Kepler's laws are still usable after a new planet is discovered, which is a pragmatic virtue. Another response to this problem would be to claim that Kepler's laws do not constitute an epistemic model but rather a tool for building epistemic models. But the current account is compatible with the idea that abstract laws such as Kepler's laws do describe an epistemic model, assuming this epistemic model could help us achieve counterfactual purposes.

So nothing in scientific practice seems to call for an amendment of my account, and once the distinction between epistemic and symbolic representation is in place, the specificities of scientific representation can be understood as pragmatic specificities, having to do with the aims shared by members of the scientific community (such as theoretical unification, generality of purposes, and hypothetical reasoning) and what they judge optimal or not for these aims.

7. Conclusion. Callender and Cohen's project of applying a Gricean strategy to the constitution problem of scientific representation is a very interesting proposal. However, their account makes only superficial use of Grice's ideas and methods and falls prey to various criticisms.

In this article, I have proposed to pay more attention to the detail of Grice's work, and I have transposed it to epistemic representation. This results in a reduction of epistemic representation to mental states that can avoid the criticisms of Callender and Cohen's account.

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There are two main novelties in the resulting conception of epistemic representation. The first one is that the target of representation is not an object but a set of afforded purposes. The second novelty is a distinction between the contextual epistemic use of a concrete vehicle and the general epistemic status of an abstract representation. The former is tied to the user's mental states, in particular her attitudes toward the reliability of the vehicle for achieving certain purposes, while the latter has to do with communal licensing of particular uses and their optimality. This important distinction, which is missing in contemporary discussions, could shed light on a number of controversies, for example, between morphism and similarity accounts of representation (Giere 1991; Bueno and French 2011), apparently focused on norms of optimality, and their critics (Suárez 2003), who seem more focused on contextual use. It explains how abstract structures can have representational status outside of a context and clarifies the connection between concrete vehicles and abstract structures, which can be analyzed in terms of indexicality.

The consequence of this account is that indeed, as Callender and Cohen claim, the relation between vehicles and targets of epistemic representation in particular contextual uses can be accounted for in terms of the mental states of the user, thus delegating the deep issues to the philosophy of mind. However, this reduction is less trivial than the one provided by Callender and Cohen, and it distinguishes symbolic and epistemic representation. Furthermore, contextual use is only one aspect of scientific representation. The other aspect involves communal values, which are not reducible to the mental states of particular users. What remains specific to science is which types of epistemic vehicles are considered appropriate and optimal within the scientific community for particular uses. Presumably, this depends on the values that bring together and animate the members of this community.

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