Time-sensitivity in Science

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Abstract

I examine the role of time-sensitivity in science by drawing on a discussion between Kevin Elliott and Daniel McKaughan (2014) and Daniel Steel (2016), on the role of non-epistemic values in theory assessment and the epistemic status of speed of inference. I argue that: 1) speed supervenes on ease of use in the cases they discuss, 2) speed is an epistemic value, and 3) Steel's account of values (2010) doesn't successfully distinguish extrinsically epistemic from non-epistemic values. Finally, I propose an account of time-sensitivity.

1. Introduction

Kevin Elliott and Daniel McKaughan (2014) argue that non-epistemic values sometimes legitimately take priority over epistemic ones in assessing scientific theories, models, and hypotheses because scientific representations are not only evaluated based on their fit with the world, but also based on the fit with the needs of their users. Their argument draws on accounts of scientific representation by Ronald Giere and Bas van Fraassen, and two examples: expedited risk assessments of the toxicity of substances (Cranor 1993, 1995) and rapid assessment methods for wetland banking (Robertson 2004, 2006). The examples attempt to show that non-epistemic values such as speed in the toxicity case and ease of use in the wetland banking case can have a more decisive role than that of being secondary considerations when epistemic values alone don't suffice to decide which representation to choose.

In a comment on their paper, Daniel Steel (2016) argues that both examples fail to show that epistemic values have been overridden by non-epistemic ones, but are rather cases in which non-epistemic values serve as secondary considerations for resolving epistemic uncertainty. According to Steel, the cases in question are not examples of accepting an epistemically inferior option because the argument rests on two problematic implicit premises: that it is epistemically better to wait for results generated by a more reliable method if one exists (E_1), and that it is bad from an epistemic perspective to select a simpler, less detailed model over one that is more complex and more detailed (E_2). In fact, in his (2010) article Steel uses Cranor's analysis to argue that non-epistemic values can influence scientific inferences without compromising epistemic ends. The problem he identifies with Elliott's and McKaughan's account is that E_1 overlooks the epistemic costs of extended suspension of judgment and therefore "threatens to entail the absurd result that scientists should never accept any claim" (Steel 2016, 610) while E_2 violates the principle of Ockham's razor. Since there are many epistemic purposes to which hypotheses can be put, some of which can favor simplicity, there is nothing epistemically wrong with choosing a simpler option. Moreover, Steel characterizes both cases as illustrative of time-sensitivity*:*

"Both illustrate what I will call *time-sensitivity*, wherein it may be better for practical or social reasons to accept the results of a quicker-but-less-reliable method rather than wait for a slower-but-more-reliable-one. In both instances, there is a pressing interest to draw inferences in a timely manner: the protection of public health in the first and the economic interest of not unduly delaying construction projects in the second." (Steel 2016, 609)

My aim in this paper is to examine the role of time-sensitivity is science. I start by arguing against Elliott's and McKaughan's view that the two tokens, speed and ease of use, independently of one another represent the same type, namely a non-epistemic value that sometimes takes priority over epistemic ones in assessing scientific representations. Besides the problem of labeling speed and ease of use as non-epistemic, I claim that in both cases speed supervenes on simplicity and ease of use, i.e. the methods are simple and easy to use in order to be fast and enable fast (soon and many) applications. Both case studies are in fact primarily about speed, as already the titles of Elliott's and McKaughan's chapters reveal: *Expedited* Risk Assessments and *Rapid* Assessment Methods.

In the third chapter I argue that speed is an epistemic value, contrary to Elliott and McKaughan and closer to Steel, but I part from the latter in that I don't think that the epistemic/non-epistemic distinction suffices for explaining decision making in science.

I proceed by examining a way to account for time-sensitivity with the help of Steel's conceptual framework. He offers a version of epistemic values which purports to argue in favor of maintaining the epistemic/non-epistemic distinction, as well as to be useful for delineating legitimate from illegitimate influence of non-epistemic values in research, namely by distinguishing between extrinsically and intrinsically epistemic values. (Steel 2010) It seems to be consistent with Steel's account to consider time-sensitivity an extrinsic epistemic value, since he argues for a broad understanding of epistemic values: "Epistemic values can be manifested by things other than theories and hypotheses, such as methods, social practices, and community structures." (2010, 19) In this case, time-sensitivity might be a value manifested by social practices. However, I show that Steel's account of values doesn't prove to be helpful for handling the epistemic/non-epistemic controversy because it fails to distinguish between extrinsic epistemic values and non-epistemic values, especially when their influence on scientific research is legitimate, i.e. when they don't obstruct the attainment of truth.

In the fourth chapter, I claim that time-sensitivity isn't captured well in either of the contrasting notions of value distinctions. I argue that time-sensitivity is not a value of methods, but of problems to be solved in their particular contexts. We implicitly or explicitly assign a degree of time-sensitivity to problems in their specific contexts, a value judgment about when we want or expect to have results from a particular instance of research, but it is neither a value exclusively external nor internal to science, but a requirement of efficiency which is both truth seeking and temporally constrained.

2. Speed Supervenes on Ease of Use and Simplicity

The first example presented in Elliott's and McKaughan's paper is based on Carl Cranor's analysis (1993, 1995) of different modelling approaches for assessing risks posed by toxic substances that are not pesticides or pharmaceuticals. In the United States the burden of proof is on the government to show that these products should be restricted or removed from the market and not on the manufacturers that produce them. Cranor analyzes trade-offs between different modelling approaches for assessing risks and concludes that social costs of relying on risk-assessment procedures which are rather accurate but slow are greater than of less accurate but quicker methodologies. This conclusion is based on the case of California Environmental Protection Agency (CEPA) which used an expedited risk assessment methodology in the early 1990s and was able to estimate carcinogenic potency of 200 chemicals in an 8 month period, while the traditional methodology was able to assess only 70 chemicals in 5 years, though with greater accuracy. The expedited procedure is called the linearized multistage default method (LMS) – it uses a carcinogenic potency data base, State of California data selection procedures and state-mandated default assumptions to facilitate otherwise time-consuming and science-intensive tasks in estimating dose-response relationships. Cranor calculates the difference between false positives and false negatives using different estimates, some more and some less favorable to the expedited approach. It turns out to be a better approach in every case, in terms of minimizing social costs connected to under-regulation of likely carcinogens. Elliott's and McKaughan's conclusion is that speed is in this case prioritized over accuracy.

The second case deals with Rapid Assessment Methods (RAMs) for assessing similarity between different wetlands as part of mitigation measures when damaging or drying wetland areas. A destroyed wetland has to be compensated by preserving or restoring another wetland area, and regulatory agencies have to decide whether the destroyed and preserved wetlands are sufficiently similar so that the two could be traded. In recent years a mitigation "banking" system is developed by regulatory agencies, developers and entrepreneurs to handle mitigation. Geographer Morgan Robertson (2004, 2006) analyzes different methods to show how the banking method differs from the methods one would use if the goal was a detailed ecological characterization. Developers purchase mitigation "credits" from specialists who create "banks" of preserved or restored wetlands, in which they focus on specific features that are considered relevant for establishing the classification of 'equivalence' between wetlands. RAMs consist of algorithms that convert data about a wetland into a numerical score that estimates a wetland's functional value and is typically represented by one main score rather than a variety of different scores "in order to keep the process simple." (Elliott and McKaughan 2014, 13) This case is supposed to be illustrative of ease of use as a value that is here taking priority over predictive accuracy. Their overall conclusion is that non-epistemic values sometimes take priority over the epistemic ones.

Against this, I argue that in these two cases, we are misled to judge speed and ease of use on a par with each other, as two tokens of the same type (a non-epistemic value that trumped predictive accuracy in assessing scientific representations), when in fact we have two cases of favoring an expedited outcome, which supervenes on ease of use.[1] Speed of inference is a value that has a decisive role of taking priority over predictive accuracy, if one wants to agree that this is what happens here, while ease of use and simplicity have only a transitive role as a means to achieve faster outcomes and applications. I don't imply that speed is always dependent on ease of use or that the benefits of ease of use and simplicity reduce to speed, but I claim that this is what is going on in the two examples. For example, a theory can be simple and easy to use, but it can hardly be fast. It would be strange to claim that Euclidean geometry is faster than non-Euclidean geometry, or that Newtonian mechanics is faster than quantum mechanics. However, here we are not dealing with theories, but rather with methods and scientific practices that use simplifications, defaults, and idealizations, designed to be applied to problems in particular contexts, and these methods and practices will most likely have simplicity and ease of use contributing to speed.

Elliott and McKaughan explicitly set out to show how non-epistemic values sometimes trump the epistemic ones such as predictive accuracy, and values that have supposedly done so are speed and ease of use. Although the second example is about making wetland

[1] To some extent, ease of use of the method supervenes on its simplicity, but this relation is not of our interest at the moment.

models easy to use, rather than being highly accurate, the reason for doing this is to make them readily available and thus – faster to use. RAMs or 'rapid assessment methods' are indeed called precisely like that, but still the argument put forward is that ease of use is the value that took priority over accuracy in this case. It is certainly a feature of the method in comparison to more sophisticated ones, but Elliott and McKaughan decided to talk about non-epistemic values in general based on the sample of two values which on the closer look turn out to be cases in which one value supervenes on the other, and that is speed supervening on ease of use, and transitively also on simplicity.

We can see the connection between simplicity, ease of use, and speed in both cases. Expedited risk assessment methodology is less science- and time-intensive, RAMs are easy to use because they are simple, and therefore the results are generated faster than it would be with methods more detailed, complex, or difficult to handle. Methods do not generate results faster in order to be easy to use but are rather easy to use in order to generate results faster. It is clear that being easy to use and being fast doesn't mean the same, but easy is *here* rather to be fast, than the other way around.

3. Speed as an Epistemic Value

The status of speed of inference is disputed in the discussion. Elliott and McKaughan claim that speed is a non-epistemic value: "The cases discussed in the following sections focus on conflicts between the epistemic value of accurate prediction versus non-epistemic values such as ease of use or speed of generating results." (2014, 7) In his comment, but also in an earlier article, Steel argues that speed is an epistemic value: “The trade-off between the speed and reliability of scientific methods, therefore, is a trade-off between two epistemic values.” (2010, 27)

First of all, not everything in science that we usually attribute values to can have the value of speed. Theories and hypothesis can’t be fast, but methods, applications, and more broadly, practices, can. Methods, together with theories, models, hypothesis (representations) constitute practices in science, and practices can trade off speed and accuracy depending on their applications to problems in certain contexts. Speed, together with ease of use, is therefore a feature of methods and broader, a feature of practices as applied to problems in contexts. Problems, unsurprisingly, need to be solved, so the efficiency of methods and practices becomes important and has a bearing on the balance between values internal to the scientific practice that addresses them. Steel’s distinction between epistemic “building blocks” and epistemic “endpoints” is useful here. Basic science is a building block for future research so it has a slower and more cautious approach when it comes to balancing reliability and speed of inference, because an error in that context is more likely to have damaging effects by leading to more errors. In contrast, scientific results that “are used primarily for some practical purpose, such as setting allowable exposure levels to toxic chemicals or predicting climate trends (…) are more like scientific endpoints than building blocks for future knowledge” (Steel 2010, 27).

Speed of inference is an internal value of scientific research – there is always a certain speed at which methods and practices operate. We might be tempted to call it non-epistemic because motivations to prioritize speed often come from outside of science and can operate on expense of accuracy. But when speed is understood as speed of getting at *true*, or *approximately* true results, then it has a clearly epistemic role because it moves us *temporally* closer to truth, i.e. it enables us to get in the possession of knowledge earlier and therefore advances our epistemic status. (See Steel 2016, 610) The non-epistemic part is still confined to different social and pragmatic reasons such as protection of health or economic benefits that instrumentalize speed for their reasons on expense of accuracy. However, speed is often a means to promote those without epistemic costs, as Steel argues. When it does so, the influence of those non-epistemic reasons is legitimate, when, in contrast, speed promotes them without appropriate consideration of accuracy, its prioritization, together with their influence, is illegitimate.

The source of influence is still social, pragmatic, non-epistemic, and speed itself, as a feature of a method or a practice, belongs to the internal part of science all along the way and has to be traded off against other epistemic values in any case. If non-epistemic reasons push the research in a direction that moves it away from the truth, they can distort the balance between different values, for example illegitimately prioritize speed of getting at *any r*esults over accuracy, but it can also happen that their influence on the trade-off is harmless or even beneficial, as I will explain later. Social reasons are the non-epistemic part here, not the speed that they instrumentalize.

4. Extrinsically Epistemic Equals Non-epistemic-but-legitimately-influencing

Steel's notion of epistemic values (2010) defines epistemic in terms of either intrinsically or extrinsically promoting the attainment of truth. Moreover, it allows that epistemic values are manifested by methods, social practices, and community structures. A value that Steel analyses at length as an example of an extrinsic epistemic value is simplicity.

Simplicity is an extrinsic epistemic value for it can be truth-promoting, but only in combination with some other intrinsic epistemic value like accuracy, at least a sufficient degree of it. Extrinsically epistemic status saves its epistemic role without commitments to generality, because circumstances matter. In contrast, empirical accuracy is an intrinsic epistemic value, and also a robust one, "in the sense of being epistemic in almost any setting", while most other epistemic values Steel calls contextual because "their capacity to promote the attainment of truth depends on occurring within a specific set of circumstances" (2010, 20).[2] Similar to simplicity, Steel would be consistent to argue that speed is a contextual and extrinsic epistemic value because it can promote the attainment of truth, but that depends on the appropriate degree of accuracy involved. In both cases discussed earlier it is precisely such a value, for it has an epistemic role granted by an accompanying degree of accuracy. This role consists in avoiding the cost of suspended judgment, which is avoiding a situation that does not bring us closer to truth.

[2] Note that his use of "contextual" is not the same as Longino's in her distinction between constitutive and contextual values (Longino 1990).

Steel's account of epistemic is not contrasted with evaluative, social, historical, contingent, or contextual in Longino's sense (2010, 23), so it allows a broader scope of factors to count as extrinsically epistemic values, such as fundability or diversity of viewpoints, as long as they play a role in attaining the truth. This is why I contend that time-sensitivity might be considered as one of Steel's extrinsically epistemic values. In the two cases from the beginning in which time-sensitivity was introduced, it was motivated by non-epistemic considerations, but since it didn't compromise epistemic norms, even more, it promoted speed and therefore served an epistemic purpose of moving us temporally closer to truth, it was certainly acting extrinsically epistemic by promoting the attainment of truth in the given circumstances.

The problem with Steel's account is that it fails to discern between extrinsically epistemic values and non-epistemic values, especially when their influence is legitimate. The central aim of his account is to save the epistemic/non-epistemic distinction because of its usefulness in the argument from inductive risk. In order to do that, he develops "a principled basis for separating legitimate from illegitimate influences of non-epistemic values in scientific inference", (2010, 14) which states that "influences of non-epistemic values on scientific inferences are epistemically bad if and only if they impede or obstruct the attainment of truths." (2010, 15) In other words, influences of non-epistemic values are epistemically harmless if they don't impede or obstruct the truth. In fact, if they are not only harmless, but also beneficial in guiding us towards truth, as I claim they can be, we can call them extrinsically epistemic. Let us take a closer look.

Steel analyses two cases in which influence of non-epistemic values is welcome, to show how this is possible. The first case is precisely about speed – how long to wait or how much data to collect before accepting or rejecting a hypothesis, and the other is about judging some mistakes worse than others. I will limit this analysis to the first type of cases. We have already seen that favoring speed, i.e. not waiting and not collecting additional, more detailed data, can be epistemically beneficial. I see no reason to regard this case as non-epistemic-but-legitimately-influencing, when it fits perfectly well under the scope of extrinsically epistemic values. If the default position of speed is for Steel extrinsically epistemic, as I contend it is, then what is non-epistemic, for example in the expedited assessment case, is the protection of human health as a value that motivates expedited risk assessments in the first place. If it doesn't obstruct the attainment of truth, but often promotes it (we can't help people by pursuing untruthful and time-insensitive practices), why wouldn't we grant it an extrinsically epistemic status as well? There is no reason for separating the status of speed and the protection of human health in this particular case when the only criterion is their relation to the attainment of truth. After all, the circumstances matter. The protection of human health in these circumstances meets the condition of an extrinsically epistemic value. This becomes even clearer if we contrast it to fundability or diversity of viewpoints whose default position in Steel's account is extrinsically epistemic. There seems to be no problem in calling fundability and diversity of viewpoints non-epistemic-but-legitimately-influencing in *some* cases. There is no grounded difference between that status and an extrinsically epistemic status.

Steel's motivation is clear: he wants to save the argument from inductive risk which claims that non-epistemic values sometimes legitimately influence scientific research. And they do, but I claim that in those cases we can also call them extrinsically epistemic. They don't impede or obstruct the attainment of truth and they often point in the direction of truth as, for example, time-sensitive practices, speed of getting at true results that they promote, and the protection of human health and economic benefits that motivate these time-sensitive practices. Introducing the intrinsic/extrinsic distinction didn't save the distinction between epistemic and non-epistemic in the way Steel hoped it would. Now there is no proper scope for non-epistemic-but-legitimately-influencing, because extrinsically epistemic values have appropriated it, along with some of the values that used to be encountered on the lists of epistemic values, like simplicity and external consistency. Either there are only intrinsic epistemic values (namely, only empirical accuracy and internal consistency), and everything else is sometimes extrinsically epistemic (when it directs towards the truth in the given circumstances), otherwise it is non-epistemic because it doesn't have anything to do with the truth-seeking endeavor; or there are robust and intrinsic epistemic values and everything else is non-epistemic, but sometimes legitimately influencing scientific research. In any case, one side of the dichotomy has to be broadly construed, be it the epistemic or the non-epistemic side.

Steel endorsed a broad notion of epistemic which doesn't fall in line with the usual epistemic side of the dichotomies (internal-external, fact-value, direct-indirect, constitutive-contextual etc.), but is constrained only by the relation to the attainment of truth. The alternative would be to be rigid on the epistemic side and count only intrinsic epistemic values as epistemic, and then carefully assess particular cases to allow for a legitimate influence of non-epistemic values in particular instances of research assessed on a case to case basis. Non-epistemic values would then have to be broadly construed to involve both simplicity and external consistency. In fact, we are left with particularism about what is epistemic and what is non-epistemic in specific cases of scientific research. I don't think that this is bad news, but it does show that Steel's distinction doesn't deliver on its promises.

More importantly, the notion of values, especially as broadly construed as Steel's, might be a misleading one in the first place. After all, not everything that we can talk about in this context is a *value*. As Justin Biddle puts it: "There are different factors that can fill the gap between 'insight' (i.e. logic, evidence, and epistemic values broadly construed) and decision making in science." (Biddle 2013, 132) I believe that time-sensitivity is a good example of such a factor.

5. Time-sensitivity

The debate in which the notion of time-sensitivity is introduced provides us with understanding of both its non-epistemic setting and its epistemic directedness. Sometimes we have social and pragmatic reasons to have the results quickly. Sometimes a scientist may want to have the results soon in order to move forward with her career or research, even if she is honestly dedicated to truth. Scientific work is embedded in time-frames: of funding, career stages, a lifetime, a generation or of several generations. Whatever the reasons may be, we will want to assign a desired time-frame for achieving certain ends in sight, even when it comes to “building block” science. We do want to see *some* results at *some* time. The assigned value of the desired time-frame is the level of time-sensitivity, and it can and does affect how different values pertaining to research practices are balanced against each other, most obviously speed and accuracy of methods. The aim of attaining the truth doesn’t only inform our methodological choices, it happens in time. It most certainly reflects an epistemic end, but is also motivated by all kinds of values and reasons. It would be misleading to call it a value, because it enters the picture as a judgment that has a say on how different values “hang” together. Even if the level of time-sensitivity is very low, it still is present.

For example, in basic science like gravitational wave physics, it takes a lot of time, computational power and extremely sensitive instruments to handle all the uncertainties related to the end-in-sight. Not long ago, the end-in-sight was the detection of gravitational waves. The time-sensitivity might have been estimated low at the beginning, especially since there are no immediate applications of the research; for now it has “only” yielded the benefit of better understanding of the universe and matter. In this case it was reasonable to expect decades of research without a robust result. However, with time passing by, the time-sensitivity of the detection attempts have grown nevertheless, because of huge cognitive and material investments which at some point require payoffs. Time-sensitivity motivates new procedures for error estimates, adding of computational power, and refinements of the instruments. Speeding up means coming up with new ways to get to the result, only in this context the tolerance for huge time-spans is higher. However, the tolerance is also exhaustive if there is no measurable advancement. This will first be reflected in the shortage of funds and then in the shortage of researchers' interest.

This particular research succeeded: gravitational waves were first detected on September 14, 2015, after more than 50 years of research. However, there are no guaranties that every research will be as successful as that, and it especially won't be the case that 50 years will be an acceptable time-span for every research practice. In comparison, recent efforts around translation in biomedical sciences are in part a reaction to the fact that the average time-span between discovery and implementation of therapeutic practices, which has been estimated 17 years (Contopoulos et al. 2008, Morris et al. 2011), is considered way too long. Unsurprisingly, since the deliverances and applications of biomedical sciences are expected with much greater urgency than that of gravitational science. This judgment is so strong that it initiated a new model of biomedical research, namely translational science, dedicated to speeding up of the so called "bench to bedside" process. Time-sensitivity does have a saying on what the next step is and which values to prioritize in different research contexts.

The examples discussed in the beginning of the paper elucidate the fact that a certain degree of time-sensitivity is present in the context in which scientific research is done, in the uses it has, and problems it aims to address. The degree of time-sensitivity is implicitly or explicitly estimated and it has a bearing on the trade-offs between different values, such as speed and accuracy. As we have seen, simplicity and ease of use transitively address time-sensitivity by contributing to speed of methods and practices. A method can generate results faster in comparison to another, and those results can be more or less accurate, but how much the setting of this activity is time-sensitive is a contextual and evaluative judgment that gives rise to concerns about efficiency and has a saying on how different methodological values are balanced against each other in particular instances of research. It doesn't fall exclusively under either epistemic or non-epistemic side of the dichotomy, it is rather informed by both: the aim of attainment of truth and the peculiarities of here and now. Highly time-sensitive issues favor expedited methods, in other words: higher the time-sensitivity, more valuable the speed.

6. Conclusion

In this paper I proposed an account of time-sensitivity, a notion introduced in Daniel Steel's comment (2016) on Elliott and McKaughan (2014). Time-sensitivity is a feature of problems to be solved in their particular contexts, a feature recognized by an implicit or explicit evaluative judgment about a desired or expected time-frame of having a result which gives rise to concerns about efficiency and influences methodological choices. I firstly pointed to speed as a value of research methods and practices that most specifically addresses time-sensitivity. Then I argued along the lines of Steel (2010, 2016) why speed ought to be considered an epistemic value, contrary to Elliott and McKaughan (2014). After that I tried to account for time-sensitivity by using Steel's distinction between extrinsically and intrinsically epistemic values (2010). I showed that his distinction fails to distinguish between extrinsically epistemic values and non-epistemic values, especially when their influence on research is legitimate.

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