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Kuhnian theory-choice and virtue convergence: Facing the base rate fallacy

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ABSTRACT

Perhaps the strongest argument for scientific realism, the no-miracles-argument, has been said to commit the so-called base rate fallacy. The apparent elusiveness of the base rate of true theories has even been said to undermine the rationality of the entire realism debate. On the basis of the Kuhnian picture of theory choice, I confront this challenge by arguing that a theory is likely to be true if it possesses multiple theoretical virtues and is embraced by numerous scientists—even when the base rate converges to zero.
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1. Introduction

Perhaps the strongest argument for scientific realism, the No-Miracles-Argument (NMA), has it that it would be a miracle if our theories were as successful as they are, and not be true. As Howson (2000) pointed out, however, as normally stated, the NMA commits the so-called *base rate fallacy:* it ignores the base rate of true theories. Expressed in Bayesian terms, it ignores the dependence of the posterior probability of a successful theory being true on the prior probability of a theory being true. But setting the base rates seems elusive. If probabilities are construed objectively, then it looks as though we have no way of finding out about them. If, on the other hand, probabilities are construed subjectively, then both the realist and antirealist can set the priors as they please. A rational debate about realism is therefore impossible (Magnus & Callender, 2004).[1]

In spite of the fact that the severity of Magnus and Callender's challenge is widely appreciated, head-on confrontations of their claims have been few and far between.[2] Whilst the current paper does little to undermine Magnus and Callender's fundamental point about the base rate dependency of the realism debate, it will nevertheless, in the face of it, try to tilt the balance to the realist's favour on the basis of the Kuhnian picture of theory-choice. In particular, this paper argues on the basis of the Kuhnian picture of theory choice that a theory is likely to be true, even when the base rate converges to zero, if it possesses multiple theoretical virtues and if it is embraced by numerous scientists on the basis of its virtues.

Although the paper will assume large parts of the Kuhnian picture of theory-choice, the purpose of this paper is not exegetical. That is, the purpose of this paper is not to reconstruct Kuhn's view of theory-choice in a way that makes best sense of his view in the context of his other works. Rather, the paper will seek to explore some interesting implications *given* (some parts of) the Kuhnian framework of theory choice.[3] The view defended here may thus very well be detrimental to some of the views held by Kuhn.[4]

The paper proceeds as follows. Section 2 specifies Magnus and Callender's challenge. Section 3 outlines how the Kuhnian picture of theory choice provides the resources for generating an argument

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[1] 1Magnus and Callender's contribution can be seen as a synthesis of earlier points made by Howson (2000) and Lewis (2001).

[2] See for example Psillos (2009) and a reply by Howson (2013). For a couple of more recent attempts see Menke (2013) and Henderson (2017).

[3] In this sense, this paper is inspired by a recent paper by Okasha (2011).

[4] In particular, much of Kuhn's work is hardly reconcilable with realism, which will be defended here. In Section 3 I will outline in detail which parts of Kuhn's account I intend to use in this paper. Should any reader with a stake in the scholarship on Kuhn object to my interpretation, I invite them to consider my assumptions in the abstract and to ignore any reference to Kuhn.

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for realism via the convergence of scientists' truth judgements about theories on the basis of those theories' virtues. I refer to this argument as *no-virtue-coincidence argument* (NVC). Section 4 develops a formal apparatus for the NVC with the help of Earman's Bayesian rendering of the convergence of witness reports. Section 5 spells out this apparatus for the NVC in detail. Section 6 proposes a way to estimate the error rates regarding scientists' truth judgements. Section 7 addresses some possible objections to my argument and provides further clarification. Section 8 concludes the paper.

2. Magnus and Callender's challenge

Magnus and Callender distinguish between 'wholesale' and 'retail' arguments for realism, i.e., arguments about "all or most of the entities posited in our best scientific theories" and arguments about "specific kinds of things, such as neutrinos", respectively (321). While they think that there may be good grounds for defending retail arguments, they urge that "the wholesale realism debate should be dissolved", for wholesale arguments amount to no more than "adamant, futile table thumping" (322).[5] Their skepticism is grounded in their claim that realists and antirealists alike commit the base rate fallacy.

The base rate fallacy can be illustrated with a simple example from the medical context. Suppose we were to test the presence of some disease T in a population of subjects with a very effective test. That test, suppose, would have a very high probability of indicating to us the presence of a disease, when the disease is really present in a subject. Let us refer to a positive test result as e. Expressed formally, then, $P(e|T) \gg 0$. Suppose further that the test has a very low false positive rate. That is, the test is unlikely to indicate the presence of the disease when it is actually absent ($P(e|\neg T) \ll 1$). For concreteness's sake, assume that $P(e|T) = 1$ and $P(e|\neg T) = .05$. Contrary to many people's intuitions, it would then be fallacious to infer that the (posterior) probability of some subject having the disease when the test indicates that the subject has the disease is high, for example $P(T|e) = 0.95$. In fact, it can be rather low. If the disease is very rare in the population (i.e., $P(T) \ll 1$), for example 1/1000 then, given the presumed high sensitivity of our test ($P(e|\neg T) = .05$), we would expect 51 subjects in a population of 1000 subjects to test positive. Since by assumption, only one of those subjects actually has the disease, $P(T|e)$ would be just 0.02, that is, much lower than the intuitive 0.95.

Magnus and Callender accuse the partakers in the realism debate of having made the same mistake. That is, they accuse realists and antirealists of having neglected the base rate of true theories in the pool of all theories/the prior probability of a(ny) theory being true. Instead the debate has focused on the probability of a theory being false if empirically successful $P(\neg T|e)$, and the probability of a theory being successful if false, i.e., on likelihood of e given $\neg T$ (i.e., $P(e|\neg T)$). Whereas antirealists have sought to increase $P(\neg T|e)$ with arguments like the Pessimistic Meta Induction, in which they have cited the existence of false theories that were empirically successful, realists have tried to decrease $P(e|\neg T)$ by for example restricting the notion of empirical success to novel success (327).[6] But without knowledge of the base rate, engaging in arguments about the posteriors appears meaningless.

Although Magnus and Callender believe that their challenge is equally futile to realists and antirealists, they pose the following dilemma to the realist:

> Either there is a way of knowing the approximate base rate of truth among our current theories or there is not. If there is, then we must have some independent grounds for thinking that a theory is very likely true; yet if we had such grounds, the no-miracles argument would be superfluous. If there is not, then the no-miracles argument requires an assumption that some significant proportion of our current theories are [sic] true; yet that would beg the question against the anti-realist. (328)

Because they see no way out of the dilemma, Magnus and Callender conclude that the entire wholesale realism debate is an irrational debate, which better be dissolved:

> Without independent methods for estimating crucial base rates, there is little to do but make arguments that beg the question. Wholesale realism debates persist not due to mere stubbornness, but because there is *no reason* for opponents to disagree (336; original emphasis).[7]

Although I think Magnus and Callender are correct in their diagnosis, the consequences of their insight can be alleviated and the second horn of their dilemma be rejected: for the no-miracles-argument to go through, the base rate of true theories need not be high.[8] In fact, they may even approach zero. In order to present the argument to this effect, we will first of all have to set up the theoretical framework in which I intend to make the argument.

3. Kuhnian theory choice and the idea of virtue convergence

In his *The Structure of Scientific Revolutions* (1962/1996), T.S. Kuhn claimed that paradigm change, such as the change from Newtonian to relativistic mechanics, or from the phlogiston to the oxygen theory of combustion, "cannot be … forced by logic [or] neutral experience" (149). Rather each paradigm comes with its own set of evaluation criteria. Whenever scientists have to choose between paradigms, "each paradigm will be shown to satisfy more or less the criteria that it dictates for itself and to fall short of a few of those dictated by its opponent" (109). In other words, paradigm change is circular in the sense that changing a paradigm must rely on the evaluation criteria that the new paradigm identifies as important (and which will be different from the criteria identified as important by the old paradigm). About ten years after *Structure* Kuhn tried to answer those who (rightly) accused him of putting the case for relativism in a seminal paper on theory choice (Kuhn, 1977). Departing from *Structure* to a degree that he probably did not quite realize, Kuhn in this paper advanced the view that there is a universal set of theoretical virtues on the basis of which scientists assess theories. Kuhn, without claiming either originality or completeness, mentions five prominent virtues: empirical accuracy, (internal and external) consistency, scope, simplicity, and fertility.[9]

Kuhn—slightly reluctantly—distinguished between an objective and subjective element of theory choice (359). The former concerns

[5] Dicken (2013) has pointed out that retail arguments risk losing sight of the philosophical substance of the realism debate.

[6] $P(T|e)$ and $P(e|T)$ are related by Bayes' theorem: $P(T|e) = \frac{P(e|T)\cdot P(T)}{P(e)}$.

[7] Similarly, when the probabilities are interpreted as subjective probabilities, Magnus and Callender also "can't imagine how one could find a reasonable set of priors" (329).

[8] See the first quotation above: "a theory [must be] very likely true"/"a *significant proportion* of our current theories [must be] true". See also Magnus and Callender's p. 325 (end of the second last paragraph).

[9] Theoretical virtues are also sometimes denoted as 'values'. In fact Kuhn himself suggested that label. I prefer 'virtues' because 'values' have ethical connotations. Recently there has been a debate about the virtues of the *scientists* making theory-choice (Ivanova, 2010; Stump, 2007). My discussion instead focuses on the virtues of *theories*.

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