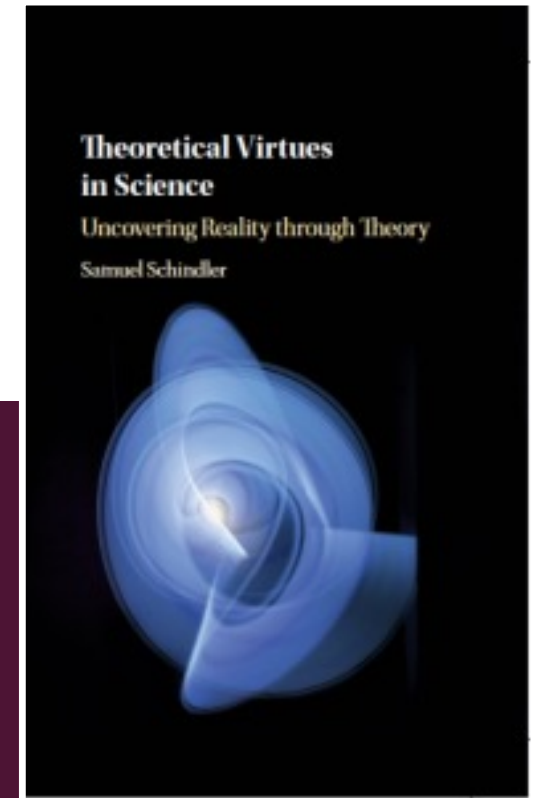

THEORETICAL VIRTUES IN SCIENCE

UNCOVERING REALITY THROUGH THEORY



INTRODUCTION

- Two inter-related questions:
 1. “what are the features that make a scientific theory good, or ‘virtuous’? and
 2. “can scientific theories help us uncover reality?” (realism debate)
- The point of the book: we have to sort out (1) in order to answer (2), but (1) has been neglected
- Method: philosophy paired with *historical case studies* from different natural sciences
 - Use of primary sources

THEORETICAL VIRTUES

- Kuhn's five 'values' and theory choice (1977):
 - accuracy,
 - consistency (internal/external),
 - scope / unifying power,
 - simplicity,
 - fertility / novel success
- Plus: testability and non-ad hocness
- The virtues also figure in other contexts ...

VIRTUES AND REALISM

- Realism debate: is belief in the truth of *unobservable entities* postulated by our best scientific theories justified?
 - E.g. electron, electromagnetic fields, spacetime, tectonic plates, etc.
- Agnosticism vs. approximate truth
- Realism and virtues:
 - Inference to the Best Explanation (IBE)
 - The No-Miracles-Argument (NMA), a type of IBE
 - Underdetermination of theories by evidence (UTE)
- Theoretical virtues of special interest: unifying power and simplicity (van Fraassen 1980)

VIRTUES AND REALISM IN MY BOOK

- Again, **my goal** in the book is to re-assess the virtues and to draw consequences for the realism debate
- The virtues in focus in my book:
 - simplicity, fertility, and non-ad hocness
- Four arguments for realism:
 - **Virtue-specific arguments:** argument from simplicity & argument from coherence,
 - **More general arguments:** no-virtue coincidence argument & argument from choice
- My position: “virtuous realism”
- In what follows: chapter-by-chapter overview

CHAPTER I: Theoretical virtues, truth, and the argument from simplicity

CHAPTER 1: Theoretical virtues, truth, and the argument from simplicity

- Is simplicity an epistemic virtue?
 - Common view: **no**, because the world would have to be simple
 - But the world is not simple, or, we don't know whether it is (see van Fraassen 1980, Douglas 2009)
- But: Why should we think that an *epistemic* criterion requires an *ontological* counterpart?
 - Lycan's analogy: it would be strange to demand that the marbel be sharp for the shisel to effectively cut through the marbel
- Could simplicity not be an epistemic virtue for *epistemic* reasons?
 - Some proposals: Forster and Sober (1994), McAllister (1999), Sober (1990, 2015)
- I have a different proposal... (based on Mill 1857 and Barnes 2000)

CHAPTER 1: Theoretical virtues, truth, and the argument from simplicity

- **Evidential-explanatory rationale (EER):** only those parts of a theory are empirically supported that are required to explain the phenomena.
- EER justifies a preference for simpler theories:
 - Suppose there are two theories T1 and T2 explaining the same phenomena
 - T1 postulates fewer entities or principles than T2
 - The additional entities postulated by T2 are explanatorily idle
 - By EER, T1 is better confirmed than T2; we should adopt T1
- But if a simpler theory is better confirmed than a more complex theory, then simplicity is an epistemic concern

CHAPTER 1: Theoretical virtues, truth, and the argument from simplicity

On my view, reality does not need to be “simple” ...

- EER provides no blanket justification for preferring simpler theories!
- Suppose that T1 postulates 32 particles and that T2 postulates 61 particles, *but only T2 explains the phenomena*
- Then we should believe in T2, rather than T1

CHAPTER 2: Pessimism, base rates, and the no-virtue-coincidence argument

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- Background: the Pessimistic Meta Induction (PMI) against the NMA
 - Problem of Unconceived Alternatives (PUA) does not pose a substantially different challenge
- One common **realist reply**: theories need to be "mature", i.e., have produced *novel* success
- Realists' **divide et impera**:
 - **Parts** of a theory that are responsible for a theory's success (and which survive theory-change) and **parts** that aren't responsible for a theory's success (and which do not survive theory-change)
 - Realists want to commit only to the "success-fueling", persisting theory parts
 - Focus of current debates

CHAPTER 2: Pessimism, base rates, and the no-virtue-coincidence argument

Magnus and Callender (2004)'s challenge:

- Realists and antirealists have been arguing about conditional probabilities:
 - Antirealists try to raise $P(S|\neg T)$ and realists have sought to keep it low (mature theories & divide et impera)
- But we cannot assess these conditional probabilities without knowing what the **base rate of true theories** is!
 - $P(T)$
- The base rate of true theories, though, is elusive; hence the entire realism debate is “irrational”

CHAPTER 2: Pessimism, base rates, and the **no-virtue-coincidence** argument

- **My argument:** a theory possessing all the virtues, and being embraced by many scientists, is likely to be true (almost) regardless of what the actual base rate is
- The argument has two parts:
 - First, a theory has to have all virtues in order for scientists with different theory choice preferences to converge on the same theory (see Kuhn 1977)
 - Second, when a large number of scientists embraces a (very virtuous) theory, the base rate can be (diminishingly) small

CHAPTER 2: Pessimism, base rates, and the no-virtue-coincidence argument

- Imagine scientists assess the truth value of a theory on the basis of a theory's virtues
- The probability of a theory being true, when it's very virtuous:
- $$P(T|V^n) = \frac{1}{1 + \left[\frac{P(\neg T)}{P(T)}\right] \times \left[\frac{P(V|\neg T)}{P(V|T)}\right]^n}$$
- Error rate: $P(V|\neg T)$ = false positive rate; $P(V|T)$ = true positive rate
- **Crucial:** so long as $P(V|\neg T) < P(V|T)$, if $n \rightarrow \infty$, then $\left[\frac{P(V|\neg T)}{P(V|T)}\right]^n \rightarrow 0$, and $P(T|V^n) \rightarrow 1$, regardless of how low $P(T)$
 - $P(V|T)$ need not be >0.5 , i.e., a virtuous theory need not be likely to be true!
 - There are principled reasons for setting the “error rates”
- Caveat: not infinitely many scientists, but $P(T)$ can still be very low (with a finite number of scientists)
- Motivation: the more critical scientists can agree on a theory being correct, the higher the probability that that is actually the case

CHAPTER 3: Novel success and predictivism

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- Predictivism: successfully predicted evidence is better than evidence known when the theory was proposed
 - Different versions: temporal novelty, use-novelty, novelty as parameter fixing, comparative novelty
- Predictivism is endorsed by most realists
- I argue that none of the rationales offered for predictivism is compelling
- If predictivism is not correct, two standard realist moves are undermined:
 - Reduction of Laudan's list (PMI)
 - Identification of success-fueling parts of theories
- Conclusion: realists should not endorse predictivism
 - Something else should ground their commitments



CHAPTER 4: Theoretical fertility without novel success

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- Usually the virtue of “fertility” is understood in terms of novel success
- Here: *fertility as a theory’s capacity to accommodate **anomalies** in a non-ad hoc fashion*
 - For example: the Bohr model’s accommodation of the fine structure in the spectrum of hydrogen
 - I call this kind of fertility M-fertility (after E. McMullin)
 - M-fertility is different from novel success: evidence is not predicted (in any of the standard ways) (contra Nolan 1997)
- I argue that M-fertility is not fuelled by the de-idealisation of a model (contra McMullin)
 - Detailed historical case study of the development of Bohr’s model of the atom
 - M-fertility, accordingly, does not support McMullin’s realism
- Regardless, M-fertility gets at something important: *non-ad hoc* accommodation of phenomena

CHAPTER 5: Ad hoc hypotheses and the argument from coherence

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- **Aim of the chapter:** conceptual explication of the notion of “ad hocness”
- Why is this important?
 - Fact: whether or not a theory is ad hoc affects a theory’s degree of confirmation
 - Judgments that H is ad hoc are *normative* judgments
 - Accounts of novel success are driven by a desire to guard against ad hoc maneuvers
 - Why don’t we tackle the problem of adhocness more directly?
- Ad hocness largely neglected topic (since the 1980s)

CHAPTER 5: Ad hoc hypotheses and the argument from coherence

- Intuitive notion of ad hoc hypotheses are hypotheses invoked to save a theory from refutation
- Problem: this tells us about motivations, not about what is (methodologically) wrong about ad hoc hypotheses
- Several accounts of ad hocness: independent testability (Popper), independent support, lack of unifiedness
- My proposal: *coherentist conception* of ad hoc hypotheses
 - H does not cohere with theory or background knowledge (it appears 'arbitrary')
 - I cash out coherence in terms of (empirically supported) **theoretical reasons** for belief

CHAPTER 5: Ad hoc hypotheses and the argument from coherence

An argument for realism:

1. Hypotheses are not ad hoc when they cohere well with theories or background knowledge
2. Such coherent theoretical 'connections' are justified when those connections are real
3. If science works well, and scientists are not systematically mistaken when detecting coherence relations, scientists should be more likely to find coherence when there actually *are* such structures
4. Science (by and large) does work well, and there does seem to be a progression to ever more coherent, less ad hoc, theories
 - E.g. Ptolemy -> Copernicus; Newton -> Einstein; standard model -> supersymmetry (?)

CHAPTER 6: Theoretical virtues as confidence boosters and the argument from choice

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- Descriptive premises
 - Historical observation: there are many cases of important discoveries in which the evidence was conflicting
 - Scientists chose to dismiss and treated as unreliable evidence against their theories without having any (experimental) justifications
 - Historical examples: Discovery of the DNA structure, Einstein's GTR and light bending, Mendeleev's contrapredictions, Einstein's STR and Kaufmann's experiments, VMM hypothesis and early data on sea-floor magnetization, GWS model and early data on WNC
- I argue that scientists' choices are explained by their theories' virtues serving as "confidence boosters"
- If theoretical virtues were not epistemic, then scientists' choices would be utterly irrational and wrong
- Philosophy of science should seek to maximize rationality (see next chapter)

CHAPTER 7: Philosophy of science by historical means

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- How ought we to conceive of the relationship between philosophy of science and history of science?
 - What are we to make of the is-ought gap?
- Views I discuss: Laudan, Lakatos, Kuhn, and Feyerabend
- The view I favour:
 1. Historical facts can *motivate* the construction of philosophical norms, but the facts do not *justify* the norms (Kuhnian mode of HPS)
 2. Philosophy of science ought to maximize the number of historical facts that can be explained rationally (see Lakatos)
 3. Philosophical norms are not to be viewed as categorical, but as *ceteris paribus* norms (see Feyerabend)
 - E.g. don't use ad hoc hypotheses unless that's your only way of saving the phenomena
- Concept clarification is another meaningful way of combining philosophical and historical methods

CONCLUSION

- The world does not have to be simple for simplicity to serve as an epistemic virtue
- Theoretical virtues need not be absolutely truth-conducive in order for the virtue to be epistemic
 - It only needs to be the case that $P(V|\neg T) < P(V|T)$, not necessarily $P(V|T) > 0.5$
- Very virtuous theories embraced by many scientists are likely to be true, almost regardless of the base rate
- Predictivism lacks a defensible rationale and realist commitments should therefore not depend on it
- Instead, I believe realism should be based on coherent theories and the (theoretical) progress of science should be understood as progress towards ever more coherent theories

EPILOGUE: The demarcation problem

- Motivation: questions about good scientific theories presuppose an answer to the demarcation problem
- Consensus: there are no necessary and sufficient criteria for scientificity
- Popular view: Wittgensteinian family resemblance view of science
 - There is nothing that all sciences have in common; just a “complicated network of similarities”
- Problem with this view: on what basis can we refuse the term “science” for anything (e.g. astrology)?
- Paradigm solution (by Simon 1969): set of predicates determines kind membership
 - Compatible with the Wittgensteinian sentiment: there need not be one feature all members of a kind share
 - Avoids the delineation problems of the Wittgensteinian solution
- My view: the “basic predicate” for science will involve theoretical virtues