Explanation, reduction, unification

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Recent directions in scientific explanation

1. (Kitcher, Friedman) explanation in terms of *unification*: explanation is matter of connecting diverse set of facts by connecting them under a set of basic patterns and principles
2. (Nagel) explanation in terms of *reduction*: explaining a theory and the phenomena it addresses by "reducing" it to a more fundamental theory
3. (Salmon) explanation in terms of *causation*: explaining a natural phenomenon is to state its (necessary and) sufficient causes
4. *pluralism* about explanation: all of these important types of explanatory relations, and possibly more
5. *contextualism* with respect to explanation: standards for good explanations depends on context, particularly on sci discipline and on historical period

Philip Kitcher (*1947)

- studied mathematics at Cambridge, philosophy/HPS at Princeton, where he obtained his PhD
- taught at Vassar College, U of Vermont, U of Minnesota, UCSD, Columbia
- phil of mathematics, general phil sci, phil of biology
- recently: "ethical and political constraints on scientific research, the evolution of altruism and morality, and the apparent conflict between science and religion" (from his website)

Logical empricism's unofficial story unveiled

Philip Kitcher, "Explanatory unification," *Philosophy of Science* **48**(1981): 507-531.

- At the outset, Kitcher makes two claims:
  1. Hempel's covering law model of explanation is fraught with difficulties
  2. but this is only the "official" view of logical empiricism, there's another one: the "unofficial" story involving unification
- evidence for the second claim: next slide
- Kitcher takes upon himself the task of developing and defending this unofficial story

Hempel: (Hempel 1966, p. 83; cf. also Hempel 1965, pp. 345, 444)

> *"What scientific explanation, especially theoretical explanation, aims at is... an objective kind of insight that is achieved by a systematic unification, by exhibiting the phenomena as manifestations of common, underlying structures and processes that conform to specific, testable, basic principles."*

Feigl: (Feigl 1970, p. 12)

> *"The aim of scientific explanation throughout the ages has been* unification*, i.e. the comprehending of a maximum of facts and regularities in terms of a minimum of theoretical concepts and assumptions."*

Two desiderata for an account of scientific explanation

A theory of explanation should...

1. "show *how* scientific explanation advances our understanding" (508)
2. "enable us to judge the adequacy of the defense" of embryonic theories "by appeal to their explanatory power" (ibid.)

Kitcher claims that the covering law model satisfies neither of these desiderata, unlike his model based on unification.

What is an explanation?

Definition (Explanation à la Kitcher)

"[A]n explantion is an ordered pair consisting of a proposition and an act type. The relevance of arguments to explanation resides in the fact that what makes an ordered pair (p, explaining q) an explanation is that a sentence expressing p bears an appropriate relation to a particular argument." (509)

"More colloquially, my project will be that of deciding when an argument explains why its conclusion is true." (510)

- One more remark: Kitcher thinks that history of sci shows that explanatory power of a scientific thy must "involve recognition of a virtue over and beyond considerations of simplicity and predictive power." (512)

The general set-up

- set of accepted sentences K
- "The general problem... is that of specifying $E(K)$, the explanatory store over K, which is the set of arguments acceptable as the basis for acts of explanation by those whose beliefs are exactly the members of K." (512)
- Answer given by the "unofficial view": "for each K, $E(K)$ is the set of arguments which best unifies K." (ibid.)

$\Rightarrow$ articulate this answer!

- start by looking at two historical examples: the Newtonian program, the reception of Darwin's thy of evolution

The Newtonian program of dynamic corpuscularianism

Characterization (Dynamic corpuscularianism)

Newton showed how one can infer the motion of bodies from a knowledge of the forces acting upon them, so many C18 Newtonians attempted to pursue this idea by postulating inter-atomic forces in order to explain phenomena they believed arose from the motion of atoms. "In searching for force laws analogous to the law of universal gravitation, Newton's successors were trying to generalize the pattern of argument presented in Principia*, so that one 'kind of reasoning' would suffice to derive all phenomena of motion." (514)*

- program remained popular so long as there was promise of unification

Kitcher's lessons

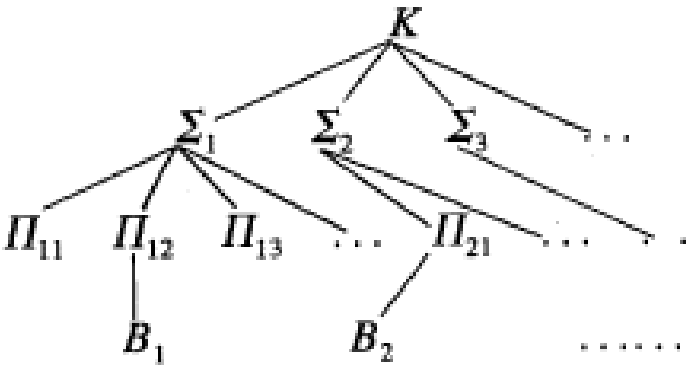
From this historic example and from the reception of Darwin's thy of evolution, Kitcher draws three morals:

1. certain programs have been favoured not bc of their predictive power–which they were yet to actualize–, but bc of their explanatory promise;
2. the explanatory power of these programs is closely tied to unification;
3. there are particular features of the thys/programs that "are taken to support their claims to unification." (512)

Kitcher's theory of explanation: terminology

- general argument pattern: roughly, a schematic argument plus filling instructions
- stringent argument patterns: roughly, patterns containing some nonlogical terms (constrained by rules of substitution) and exhibiting similar logical structure (subject to conditions of similarity)
- Goal, as stated before: specify, in a principled way, which set of arguments $E(K)$ best unifies or systematizes K
- lesson from historic examples: unification is achieved by using similar arguments in derivation of many sentences of K
- Σ is a set of arguments, Π is a set of argument patterns
- Σ is generated by Π if each argument in Σ is an instantiation of some argument in Σ
- conclusion set $C(\Sigma)$ of a set of args Σ: set of sentences which occur as conclusions of some argument in Σ

More terminology and a picture



- Among all the set of arg patterns Π of Σ, select the one w/ the greatest unifying power (this set is called the basis B for Σ.
- Among all the bases B_i, select the one w/ the greatest unifying power.
- If B_k is this basis, then $E(K) = \Sigma_k$.
- On first pass: unifying power of B_i wrt K varies directly w/ size of $C(\Sigma)$, varies directly w/ stringency of patterns in B_i, varies inversely w/ size of B_i

Two corollaries

Corollary (A)

"Let Σ, Σ' be sets of argument which are acceptable relative to K and which meet the following conditions: (i) the basis of Σ' is as good as the basis of Σ in terms of the criteria of stringency of patterns, paucity of patterns, presence of core patterns, and so forth. (ii) $C(\Sigma)$ is a proper subset of $C(\Sigma')$. Then $\Sigma \neq E(K)$." (522)

Corollary (B)

"Let Σ, Σ' be sets of argument which are acceptable relative to K and which meet the following conditions: (i) $C(\Sigma) = C(\Sigma')$ (ii) the basis of Σ' is a proper subset of the basis of Σ. Then $\Sigma \neq E(K)$." (ibid.)

Reminder: two major problems for the D-N model

1. Asymmetry
2. Irrelevance

(a) Solving Asymmetry

Whoever accepts that the specification of the period (together with laws about pendula) is explanatory of the length of a pendulum, can be hit with a dilemma:

1. either two patterns of argument must be adopted bc a different pattern will be needed in the explanation of the length of non-swinging bodies
   $\Rightarrow$ violation of Corollary B
2. or only one pattern is adopted, but the relevant discourse will be limited to cases of swinging pendula
   $\Rightarrow$ violation of Corollary A

$\Rightarrow$ Either way, the candidate explanation does not live up to the standards as set by the unificationist account and should therefore not be considered an explanation.

(b) Solving Irrelevance

Whoever accepts that the dissolving of the hexed salt is explained by an appeal to its being hexed, can be hit with a dilemma:

1. either two patterns of argument must be adopted bc a different one will be needed for unhexed salt
   $\Rightarrow$ violation of Corollary B
2. or only one pattern is adopted, but the relevant discourse will be limited to cases of hexed salts
   $\Rightarrow$ violation of Corollary A

$\Rightarrow$ Either way, the candidate explanation does not live up to the standards as set by the unificationist account and should therefore not be considered an explanation.

My challenge to Kitcher

- Consider once again the case of John's failure to get pregnant after having regularly taken birth control pills.

$\Rightarrow$ If it's the regular taking of birth control pills that explains John's failure to get pregnant, then we can use the same argument pattern (and it should be considered stringent according to Kitcher's conditions).

$\Rightarrow$ more unified explanatory pattern (same in males and females), in concordance with the demands of Corollary B

- It seems as if any explanation for males that would differ from the ones offered for females would decrease in unifying power.
- Or is this a case of spurious explanation?

Spurious unification

- Problem: anything can be derived from it conjoined with Boyle's law
- Answer: this would be a spurious unification

Definition (Spurious unification)

"If the filling instructions associated with a pattern P could be replaced by different filling instructions, allowing for the substitution of a class of expressions of the same syntactic category, to yield pattern P′ and if P′ would allow the derivations of any *sentence, then the unification achieved by P is spurious." (527f)*

- idea: genuinely unifying patterns should not be able to accommodate all conclusions