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The British Journal for the Philosophy of Science, Vol. 42, No. 2 (Jun., 1991), 263-268.

Stable URL:
http://links.jstor.org/sici?sici=0007-0882%28199106%2942%3A2%3C263%3AACNOJS%3E2.0.CO%3B2-3

The British Journal for the Philosophy of Science is currently published by Oxford University Press.

Brit. J. Phil. Sci. **42** (1991), 263–268 *Printed in Great Britain*

DISCUSSION

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Four distinct landmarks of the various attempts to grapple with the problem of error can be discerned from a broad perspective. Aristotle acknowledges and analyses the possibility of error in perceiving the common sensibles, and draws attention to the deceptiveness of appearance. He, however, claims that perception of the specific sensibles is immune to error. On this view, errors originate not only in the application of the senses under abnormal conditions—be they internal or external—but mainly in the transition from sensation to appearance. Bacon starts his new methodology with an analysis of the obstacles to epistemological progress, namely, the idols: fleeting images of reality. He identifies four categories of idols which he orders according to their origin; the first type of idols is innate, whereas the fourth is entirely imposed from without. For Bacon errors are principally prejudices and preconceived ideas which could and should be purged. They have to be eliminated to allow the construction of a true copy of the universe in the human intellect. Descartes examines the mechanism which produces erroneous ideas and finds it to be based on the discrepancy between the scope of the will and that of the understanding. According to Descartes errors occur when one misuses one's free will and forms judgements on matters which the understanding has not conceived clearly and distinctly. In Spinoza's rigid deterministic view there is no room for what may be called absolute errors, that is, errors which arise out of totally misguided ideas. On this view, errors originate in the privation of knowledge which mutilated and confused ideas involve. They are the consequences of knowledge of the first kind, namely, imagination, and would dissolve if they were to be supplemented with true ideas (Hon [1985], pp. 11–27).

Notwithstanding the differences, these philosophical systems have in common the belief that knowledge amounts to truth: they all presuppose the possibility of eliminating all errors. Although they acknowledge fallibility they do not regard it as an inherent feature of the systems they propound.

John Stuart Mill (1806–1873), who advocates an empirical doctrine, diverges from this dogmatic way. For Mill there is always in natural philosophy some other possible explanation of the same facts: 'some geocentric theory instead of heliocentric, some phlogiston instead of oxygen' (Mill [1859], p.

163). According to Mill, 'it has to be shown why that other theory cannot be the true one: and until this is shown, and until we know how it is shown, we do not understand the grounds of our opinion' (Mill [1859], p. 163). Mill does not pay lip service to fallibility; rather, he considers it a principle from which he can derive pluralism—the leitmotiv of his celebrated essay 'On Liberty'.

Mill attributes the sense of complete assurance of the truth of Newtonian physics to the fact that it has withstood incessant questioning (Mill [1859], p. 147). He openly admits that 'the beliefs which we have most warrant for have no safeguard to rest on, but a standing invitation to the whole world to prove them unfounded' (Mill [1859], p. 147). Having reached this conclusion, he resigns himself to the view that this is the amount of certainty a fallible being can attain (Mill [1859], p. 147).

However, for Mill the source of everything respectable in man—either as an intellectual or as a moral being—is that his errors are corrigible (Mill [1859], p. 146). In this connection the moral parallel is instructive and worth expanding.

Consider the religious and moral concept of the Fall of Man. In one of the most glorious hymns from the magnificent liturgy, the Exultet of the Easter Vigil according to the Latin rite, there occurs the seemingly paradoxical phrase: '*O felix culpa*', that is, 'the Fortunate Fall'. In this religious tradition, Adam's sin has precipitated the latent elements of evil. The question therefore arises as to the way in which the Fall can be fortunate? A possible interpretation suggests that the Fall can be considered a decisive mechanism of purification: through it man can recognize evil and be expected to eject it consciously. In other words, it is Adam's freedom of choice that allowed for his sin and thereby made him bring upon himself an ultimately fortunate fall. It is indeed fortunate, since the recovery from the Fall makes it possible, in effect, to lead a moral life. The Fall has made the awareness of evil possible; with this knowledge man can choose to struggle back to a moral state, far superior to that which would have been his lot had he never fallen in the first place (Werblowsky [1979])[1].

By analogy, one may coin the phrase '*O felix erratum*', that is, 'the fortunate error'. Error, it can be maintained, is instrumental in attaining or—in view of the moral parallel—ascending to knowledge. As much as the comprehension of the Fall is the signature of moral life, so it is the understanding of error that marks epistemological attainment. 'It is the capacity of making mistakes, not the incapacity of it', as H. H. Price succinctly puts it, 'which is the mark of the higher stages of intelligence' (Price [1953], p. 87). Indeed, Price continues, we should congratulate 'any creature which is clever enough to be caught in a trap' [1953].

But what are the traps that lurk in the path to knowledge? Mill enquires into this problem and attempts to elucidate the nature of these traps. He prefaces his

[1] I am grateful to Y. Bronowski for calling my attention to this paper. *Cf.* Lovejoy [1948].

book on fallacies—the fifth in his *System of Logic*—with Malebranche's view that it is not enough to say in general that the human nature is infirm, and just to be on guard against one's prejudices. To be content with the admission that the spirit is subject to error would not suffice; one has to make the spirit realize in what its error consists (Mill [1843], Volume 2, p. 332). And indeed Mill opens his book on fallacies with the scholastic maxim: '"*Contrariorum eadem est scientia*": we never really know what a thing is unless we are also able to give a sufficient account of its opposite' (Mill [1843] p. 333).

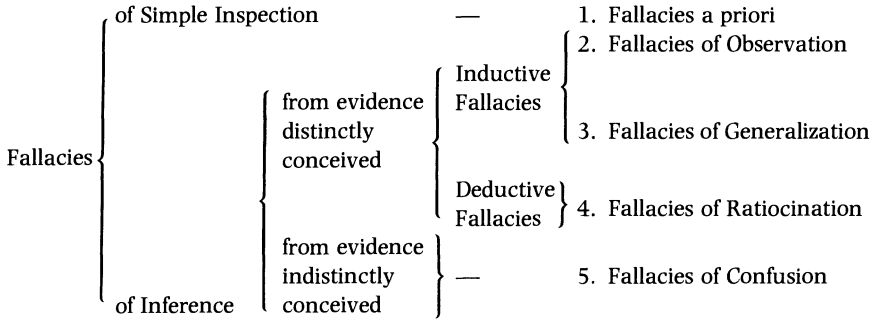
Although Mill advocates an empirical doctrine, he nevertheless addresses himself explicitly to the problem of fallacy—the title of his study is 'Classification of Fallacies'—and not to that of error, let alone experimental error. This approach does not indicate in itself that Mill evades the issue of error in science altogether. On the contrary, upon analysing, for example, chance and its elimination, he observes that unavoidable errors can affect the result of an individual experiment (Mill [1843], p. 65). In accordance with the mathematical theory of error, Mill states that 'we have... to repeat the experiment, until any change which is produced in the average of the whole by further repetition, falls within the limits of error consistent with the degree of accuracy required by the purpose we have in view' (Mill [1843], p. 66). Moreover, looking for evidence of universal causation, he admits that 'errors... may have slipped into the statement of any one of the special laws, through inattention to some material circumstances; and instead of the true proposition, another may have been enunciated, false as an universal law'.[2] And noting that observation is the first stage among the operations subsidiary to induction, he suggests that one has to consider under what conditions observation is to be relied upon; (Mill [1843], pp. 201–2) 'what is needful', as he puts it, 'in order that the fact, supposed to be observed, may safely be received as true' (Mill [1843], p. 202). In this instance Mill follows Aristotle and claims that sensations are always genuine: errors of the senses are in fact erroneous inferences from the senses.[3]

Thus Mill appears to be aware of the general problem of error and moreover, as an empiricist, he acknowledges the problem of experimental error which arises in experimentation. Hence, whoever is interested in the problem of error in experimentation will look forward to examining Mill's study, notwithstanding its title ('Classification of Fallacies') which suggests only logical analysis. The disappointment is, however, considerable.

[2] Mill [1843], Volume 2, p. 118. However, Mill holds that such errors cannot undermine the general law of causation. Indeed, he states that the law 'would remain unaffected by any such error' (Mill [1843], p. 119). For Mill, 'the law of cause and effect is therefore... placed, in point of certainty, at the head of all our induction' (Mill [1843], p. 119).

[3] 'Innumerable instances might be given, and analysed', Mill writes, 'of what are vulgarly called errors of sense. There are none of them properly errors of sense; they are erroneous inferences from sense'. Mill explains that 'the deception whether durable or only momentary, is in my judgement. From my sense I have only the sensations, and those are genuine' (Mill [1843], Volume 2, pp. 202–4).

Mill distinguishes five classes of fallacy, which he expresses in the following synoptic table (Mill [1843], p. 344; *cf.*, Hamblin [1972], pp. 48–9):



Fallacies a priori are false beliefs, prejudices or superstitions which bias the observer upon examining a subject matter. These fallacies are of simple inspection and Mill distinguishes them from the rest of the four categories which are of inference. Thus, the four remaining categories are concerned with erroneous conclusions from supposed evidence, and are therefore divided according to the nature of the supposed evidence from which the conclusions are drawn (Mill [1843], Volume 2, pp. 340–1). The two principal categories of inspection and inference reflect Mill's view that there are 'two parts of the process of philosophising, the inferring part, and the registering part' (Mill [1843] Volume 1, Book. II, Chapter 3, no. 3).

The first two categories of inference pertain to the inductive method. Fallacies of observation constitute the class of all inductions of which, as Mill puts it, 'the error lies in not sufficiently ascertaining the facts on which the theory is grounded' (Mill [1843], Volume 2, p. 343). The second category of the inductive method is that of faulty induction and false analogies, that is, the facts are correct but they do not warrant the conclusion (Mill [1843], p. 343). The deductive fallacies, those of ratiocination, are clearly formal, namely, modes of incorrect argumentation; they consist mainly of vicious syllogism (Mill [1843], pp. 343–4). The final category represents a miscellaneous collection of fallacies in which the source of error is an indistinct, indefinite, and fluctuating conception of what the evidence is, such as question begging and irrelevant conclusion (Mill [1843], pp. 342, 344. Hamblin traces here the influence of Bentham on Mill (Hamblin [1972], p. 49)).

The interesting thing about this classification is that though it bears the mark of Mill's empiricism, namely, it includes the method of induction, it still retains the features of a classification of logical fallacies—the emphasis being on the descriptive term 'logical'.[4] However, it seems that Mill does not strike

[4] According to Hamblin, 'Mill's account of fallacies... is strongly oriented, at least superficially, in [the direction of unjustified inductions]' (Hamblin [1972], p. 29).

the right balance between fallacy and error. The interchangeable use which he makes of the terms 'fallacy', 'error' and 'mistake', suggests that he is much more concerned with logic than with the method of experimentation. Appropriately to a system of logic, Mill stresses the logical aspect of reasoning, namely, inferences, but that is achieved at the expense of an account of errors in general and experimental errors in particular. Notice that although Mill professes an empirical doctrine, he proposes only one category which pertains directly to experimentation, namely, the category of fallacies of observation, and that is subsumed under fallacies of inference. Moreover, in this category he points out that induction is not always grounded upon facts immediately observed; one should also consider the case of facts inferred. When the latter are erroneous, the error is not, as Mill explains, 'an instance of bad observation, but of bad inference' (Mill [1843], Volume 2, p. 343). He thus draws a distinction between what he calls mal-observation and simple non-observation (Mill [1843], p. 343). In his view, mal-observation may occur due to mistaking inferences for perception. 'The logic of observation', Mill holds, 'consists solely in a correct discrimination between that . . . which has really been perceived, and that which is an inference from the perception' (Mill [1843], p. 205).

Evidently, the underlying criterion of Mill's classification is logical. His professed empiricism appears to bear layers of a different metaphysical outlook, namely, rationalism. His attempt to tackle the 'whole process' of argumentation in science: 'whether the ratiocinative or the experimental portion' (Mill [1843], Volume 2, Book. V, Chapter 1, no. 1) proved imbalanced and predisposed towards the ratiocinative element. Nevertheless, Mill's attempt to classify experimental errors—albeit only observational errors—within the framework of a classification of fallacies, points at the right direction for carrying out the enterprise of classifying experimental errors in a comprehensive fashion.

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