Two Notions of Justification in Science

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The sciences are not only the most sophisticated human enterprise of knowledge gathering, they are at the same time epistemically self-conscious to a considerable degree. Assessments of the epistemic status of data, inferences and theories play an important role in the very practice of science, which therefore includes a wealth of epistemic notions, norms and considerations. In one sense of the expression "epistemology of science", some sort of an epistemology is thus included in scientific practice. This epistemology is usually captured under the heading of methodology, and its explication – e.g. concerning the standards of confirmation or theory choice – has also been a central business of the philosophy of science. Still, there are further epistemological questions about scientific knowledge claims that are typically not addressed within scientific practice. These include topics such as the underdetermination of theories by all evidence, the no-miracle argument, or the theory-dependence of observations. In the present paper, I will discuss the notion of justification that is operative in science and thus try to shed some light on the relation between the two epistemologies.

1. Two notions of justification

A central activity of any epistemic practice is the assessment of knowledge claims as justified or not justified (viz. as epistemically acceptable or not acceptable)[1]. In general epistemology, two notions of justification are often distinguished. First, for a cogniser to be justified in her beliefs, she has to be rational with respect to her beliefs. This means that she has to possess good reasons for holding them and to be able to respond adequately to challenges. This notion of justification is often taken to capture what it is to be epistemically responsible, viz. to fulfil the duties one has concerning one's believing. Therefore I will call it the deontological notion of justification. Second, on the alethic notion, a cogniser is justified if her beliefs are likely to be true, e.g. if her methods of belief formation are reliable and thus generally truth-conducive. Justification in this sense is conceptually tied to indicating likely truth. But this opposition of notions does not mean that deontological justification has nothing to do with truth, since a reason for a belief is something that can be *taken* to speak for the belief's truth. Still, the assumption behind the distinction is that, in deviation from a long tradition in epistemology, it is not conceptually or metaphysically necessary that what is rational to believe is therefore also likely to be true (or the other way round). In a world ruled by a Cartesian demon, one can be fully rational and fulfil the epistemic duties without the beliefs being likely to be true. And for someone with a rare but reliable faculty of clairvoyance, the thus formed beliefs can always be true without the subject being rationally entitled to hold them (Cp. Alston 1998). The deontological and alethic notions are therefore distinct.

In the light of the two notions of justification, scientific justification seems to be largely deontological. Scientific claims in general count as justified or challenged to the extent that specific reasons can be adduced. A choice between alternative theories, for instance, is scientifically acceptable if it balances conditions like empirical accuracy, internal and external consistency, broad scope, simplicity, and fruitfulness (Kuhn 1977, 321-322). It is not made to depend conceptually on the actual truth-conduciveness of this set of standards. On reflection, this does not come as a great surprise. Deontological justification, by definition, has to be one that can be followed by cognisers, and that can thus be operative in an epistemic practice. In contrast to this, alethic justification refers to the actual likelihood for truth, which is not what is in general transparent to cognisers. It therefore typically cannot be followed in a straightforward way in one's believing, and hence cannot be directly implemented in an epistemic practice.

Still, the scientific notion of justification is special in at least two respects. First, deontological conceptions of justification in general epistemology often go with internalism. Since a cogniser can only have the epistemic duties that she can fulfil, the reasons for or against believing that she might have to adduce have to be accessible to her. In line with the strong individualist emphasis of traditional epistemology, this condition of accessibility has typically been spelt out in terms of privileged access by the individual subject of cognition. The prototypical states and processes that are, in this sense, accessible include the subject's perceptual experiences, her memory and her inferences. In contrast to this, the scientific notion of justification pays tribute to the fact that science is a communal project of knowledge gathering. For a theory to be acceptable for a scientist, not only the reasons accessible to her by introspection, but any reasons accessible to the scientific community have to be taken into account. She can be blamed e.g. for ignoring published evidence that contradicts the theory. Since only the extensive division of labour between scientists across history, different subdisciplines and different specialisations (as experimenters, theorists etc.) makes today's scientific findings humanly achievable, scientists in their believing have to rely on results the scientific assessment of which they cannot entirely redo by themselves. This mutual dependence leads to some form of externalism: Scientific results count as accessible to a believer even though they cannot be comprehensively checked by her on the basis of what she has privileged access to.

Second, the question whether processes of producing results are reliable is regularly posed. This applies in particular to observations and the generation of empirical results. Since standard alethic accounts of justification also refer to the reliability of processes of belief formation, one might wonder whether scientific practice does not incorporate here the alethic notion. I will address this issue by looking more closely at the scientific standards for assessing the reliability of observation results.

2. Assessing the reliability of observation results

Observational data come in a wide variety in the sciences. At one end of the spectrum (or better at one end of a multi-dimensional continuum), there are empirical results that are obtained by highly complex, extensive experiments. One such result is the finding that solar neutrinos change

[1] Since I am here only interested in the structure of the scientific epistemic assessment, I will not distinguish between justification and acceptance, even though one can argue that the epistemic attitudes that are licensed either by acceptability or justification – namely acceptance or belief – are different.

their 'flavour' on their way to the earth, which has been shown by data gained at the Sudbury Neutrino Observatory in Canada (Ahmad et al. 2002). The data are obtained from a detector that is situated in a copper mine 2000 metres below the surface. About 1000 tons of heavy water were deposited there, with sparks occurring in it being registered by photomultiplier tubes. In order to assess the data as reliable, a wide range of considerations and provisions had to be made. For example, the detector is placed in the mine in order to shield off cosmic rays, and it is additionally surrounded by 7000 tons of ordinary water to absorb neutrons and gamma rays from the rock. The data have been collected over a period of more than a year, and have considerably been processed and analysed. For instance, the neutron background had to be subtracted, which had before been determined by calibrating the detector with an artificial neutron source. Altogether, from the more than 300 million initially triggered events, about 1000 have been selected as relevant data base (Ahmad et al. 2001).

In cases like this, a large number of both empirical and theoretical considerations about the process of data generation and selection is altogether adduced to assess the final results.[2] This shows that science is epistemically self-conscious: What one knows scientifically about the reliability of the generation of scientific findings enters into the epistemic assessment of these findings. But this does not mean that science is here committed to the alethic notion of justification. While the reasons concern the truth-conduciveness of the observation processes, it is only reasons insofar as they are accessible to the scientific community that matter. For example, the theoretical understanding of the different processes of neutrino interaction are of central importance for gaining the result. But it is the standard theories that enter here as conditions of justification, not the real processes that take place. If the two came apart, i.e. if, in retrospect, we would find that physicists were in error about the neutrino interactions, we would still think that they were scientifically justified in drawing their conclusions, if the error is not of their fault. But this is to say that the deontological notion of justification is dominant.

The deontological notion makes one expect that justification is defeasible. An observation that is acceptable at some point of time might be judged to be unreliable as further knowledge on its generation is acquired. Observations from the other end of the above mentioned spectrum can illustrate this defeasibility.

This end is occupied by simple direct perceptions of scientifically interesting phenomena (the intermediate continuum being filled with, among others, perceptions made with instruments and results from measuring instruments or imaging techniques)[3]. Results from direct perception are usually accepted without further reasons being given for their reliability. When scientists report that they have seen, in their laboratory, a litmus paper turn pink, they are not asked to give reasons for assuming that their sensory experiences are in general good indicators as to the colour changes that occur or that the conditions for the observation have been favourable. Instead, the results are taken at face value.

Still, the acceptance is defeasible and can be undermined by specific reasons that question the reliability of particular perceptions. This can be illustrated by Galileo's discussion of the tower-experiment. A stone falling from the top of a tower is perceived to fall in a straight line. However, according to Copernicus' theory, the earth and with it the stone also revolve. Therefore, the stone is taken really to move mixed straight and circular. The direct perception, taken at face value, contradicts this consequence of Copernicus' theory. Following Copernicus, Galileo however argues that with respect to real motion, direct perceptions are unreliable. This is supported by assumptions about the perception of motion. Galileo assumes that an object appears to be moving only if, in order to keep track of the object, the observer has to move her eyes. But insofar as observer and object move uniformly, the eyes do not have to be moved to follow the object. Therefore, only the motion of the object relative to the observer, not the common motion is perceived, and the direct impression of the falling stone does not reliably indicate the stone's real motion (Galileo 1632, 248-250).

The scientific policy concerning direct perceptions then seems to be that they count as *prima facie* acceptable, but the acceptance can be undermined by specific reasons as to them being unreliable. Again, it would be wrong to count these standards as alethic. Justification is not made to depend on direct perception actually being reliable, but on the scientific availability of specific reasons against the reliability. Also in this case, the scientific standards of justification are deontological and refer to all scientifically accessible reasons.

At the same time, some pertinent epistemological questions are not addressed within this scientific practice. Why is it advisable to accept direct perceptions at face value unless specific reasons speak against their reliability, while more elaborate observation results are in need of substantial empirical and theoretical underpinning? I take it that an answer would have to refer to the different roles that the relative dependence and independence of observations from theories play for the empirical basis of science. While the – arguably – largely theory-independent direct perceptions allow for a neutral input to science, the empirical basis of science is enormously extended when theories guide and validate more sophisticated observational results (see Adam 2002). But the details of this answer notwithstanding, an answer of this type would address the question whether the scientific enterprise, proceeding as specified by its internal methodological rules, is on the whole likely to find the truth. In other words, it would assess scientific claims according to the alethic notion of justification.

3. Conclusions

All in all, the scientific epistemic practice on the one hand includes a deontological notion of justification. Yet the notion is not internalist, since reasons that are communally accessible and also concern the reliability of the worldly generation of scientific findings are relevant. On the other hand, the discussion of observational results has shown that a number of epistemological issues are not addressed within science. These can be subsumed under the question whether the scientific practice as characterised by its internal epistemic rules is on the whole likely to lead to true claims. It seems to me that established discussions on topics such as the underdetermination of theories by empirical evidence, the no-miracle argument or the theory-dependence of observation are best viewed as working largely on this question. But to ask for the truth-conduciveness of the scientific method is to ask whether scientific claims are justified in the alethic sense.

[2] Cp. Shapere 1982 and Galison 1987, Chap. 4 for cases with a similar role for theoretical and empirical considerations.
[3] For a discussion of the scientific standards for assessing the reliability of such observational results, see Adam (2002), chapt. 5.

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