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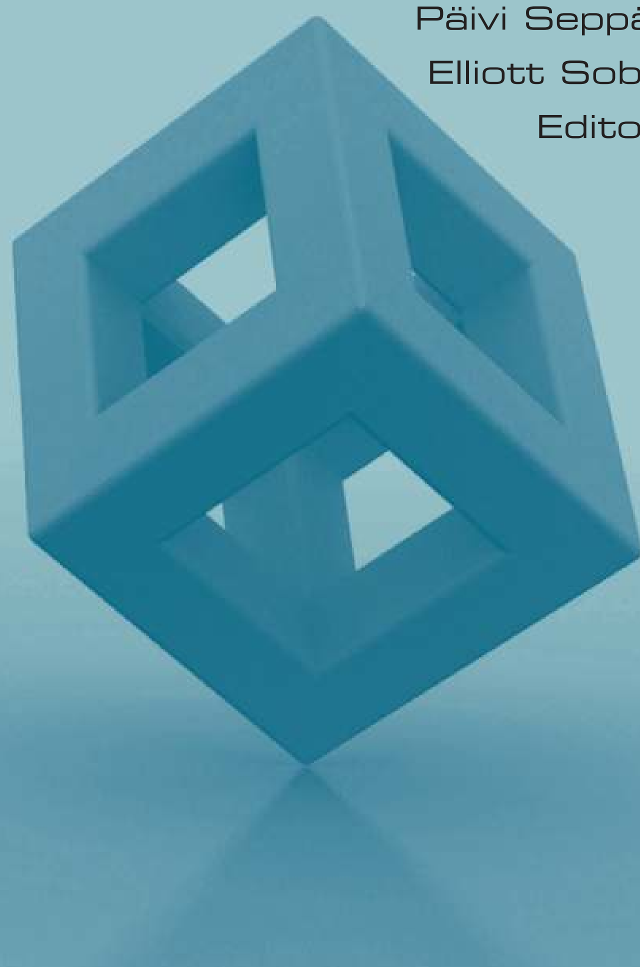

11 How values can influence science without threatening its integrity

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Abstract. Science provides us with a common set of highly plausible factual beliefs, the scientific corpus. It consists of those statements in the domain of science that we currently see no reason to doubt. In most cases our practical purposes are well served by basing our decisions on the information that is available in the corpus. But the fit is not perfect. Two major types of conflict can arise between the criteria of corpus entry and those of practical decision-making. The first type of conflict arises when we have reasons to act as if some statement is true, even though the evidence is not strong enough for accepting it as scientifically valid. In such cases we do not typically adjust the requirements for scientific acceptance downwards, but instead distinguish between different criteria for scientific and practical purposes. The second, much less discussed, type of conflict arises when a higher level of evidence is required for acting as if something is true than for accepting it as scientifically valid. In such cases we typically adjust the requirements for scientific acceptance upwards so that they coincide with what is called for in the practical decision. Such adjustments are seldom explicitly discussed but they are common for instance in medical science. With this implicit, but rather sophisticated, two-branched strategy we can apply the appropriate criteria of evidence in practical decision-making while at the same time upholding the integrity of science and keeping down the conflicts between scientific and practical criteria to a minimum.

Keywords: epistemic values, practical decision, scientific corpus, value-neutrality.

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1 Introduction

In this contribution I will propose a new take on an old debate, namely whether practical (non-epistemic) values should be allowed to influence science.[1] There are of course many ways in which values can have an influence in science. For instance, they can have impact on the choice of issues to investigate and on what methods of inquiry are considered to be (ethically) acceptable. Following a common practice in this debate I will only consider the influence that values can have on what statements we assent to, given the evidence at hand. I will call this influence on *scientific assent*.

According to what is often called the "traditional view", judgments of scientific assent should be uninfluenced by our values and wishes, especially by ethical and political values. (Merton, [1942] 1973) In a famous paper, Richard Rudner (1953) claimed that in spite of its intuitive appeal, this viewpoint is untenable in scientific practice. His main argument was that a decision whether or not to accept a scientific hypothesis must take into account not only the available empirical evidence but also the seriousness of the two possible types of mistakes: accepting an incorrect hypothesis and rejecting a correct one.

> Thus, to take a crude but easily manag[e]able example, if the hypothesis under consideration were to the effect that a toxic ingredient of a drug was not present in lethal quantity, we would require a relatively high degree of confirmation or confidence before accepting the hypothesis – for the consequences of making a mistake here are exceedingly grave by our moral standards. On the other hand, if say, our hypothesis stated that, on the basis of a sample, a certain lot of machine stamped belt buckles was not defective, the degree of confidence we should require would be relatively not so high. *How sure we need to be before we accept a hypothesis will depend on how serious a mistake would be.* (Rudner, 1953, p. 2)

In a reply to Rudner, Isaac Levi (1960) conceded that scientists have to assign "minimum probabilities for accepting or rejecting hypotheses" but argued that these numbers can be part of the scientific standards of inference that scientists are committed to. He adjusted the value-neutrality thesis accordingly, saying that "the value-neutrality thesis does not maintain that the scientist *qua* scientist makes no value judgments but that given his commitment to the canons of inference he need make no further value judgments in order to decide which hypotheses to accept and which to reject." (Levi, 1960, p. 356) In a similar vein, Carl Hempel (1960) proposed that scientists should

[1] The word "science" will be used in an extended sense that includes the humanities (like the German "Wissenschaft"). For a clarification why this is a better demarcation than the conventional English one, see Hansson (2013). Science is formed by a community of knowledge disciplines that share the same overarching goal of providing us with a joint repository of reliable factual knowledge. They are also characterized by mutual respect for each other's results and methods.

be influenced by "the value or disvalue which the different outcomes have from the point of view of pure scientific research rather than the practical advantages or disadvantages that might result from the application of an accepted hypothesis". He called these "purely scientific, or epistemic, utilities" (Hempel, 1960, p. 465). Later he called them "epistemic values" and maintained that epistemic values should reflect the usefulness of truth, simplicity, explanatory power and other desiderata of scientific theories (Hempel, 1981, p. 398). This is the modern version of the value-neutral ideal. It has been defended at least in part for instance by Hugh Lacey (1999) and Gerald Doppelt (2007).

There is also a parallel debate in modern epistemology. It is couched in terms of individual rather than collective knowledge claims, and refers to knowledge in general rather than scientific knowledge. Discussions concern whether a person's values etc. can have a legitimate influence on her beliefs (Vahid, 2014) and whether the fact that someone knows something is sufficient reason for her to rely on it in practical reasoning. (Brown, 2008; Buckwalter, 2010; Fantl & McGrath, 2007; Hawthorne, 2004; Stanley, 2005)

In Sections 2-3 some preconditions will be presented that are essential for the argument. Section 4 investigates cases in which practical decisions have to be based on criteria of evidence that differ from those used for internal scientific purposes. In Section 5 this investigation is extended to cases in which different internal scientific purposes can give rise to divergent criteria for scientific assent. In Section 6 and the concluding Section 7 it will be argued that the pattern uncovered in the previous sections represents an implicit yet highly sophisticated practice that allows the criteria of scientific assent to be influenced by practical, non-scientific, considerations only in the cases when this can be done without damage to the integrity of science.

2 Separating facts and values

It is a basic fact about human reasoning that we separate, or make a distinction between, facts and values. As individuals we distinguish our factual beliefs from our other attitudes and reactions to what is happening around us. In some social contexts, including science, this separation is further refined. Such processes seem to be present in all types of human societies, including illiterate ones. For instance, !Kung hunters discussing animal behaviour take great care to distinguish facts (for instance tracks that they have seen) from theories and attitudes. (Blurton-Jones & Konner, 1976)

We do not know much about how members of other species "think". In particular, we do not know whether or not they have mental representations of factual circumstances that are separate from the mental representations of reactions or attitudes to these circumstances. For instance, when a python is in the process of digesting a large prey, it can let a rat pass within strike range without trying to snatch it. Does this inactivity depend on some factual belief ("this is not a tasty prey"), a judgment of value ("it is not good for me to take this tasty prey"), or some mode of thinking that is devoid of this distinction? The latter option is far from implausible. But why then do we humans make the fact/value distinction?

I have found no other credible answer to that question than that maintaining such a separate sphere of facts makes us more successful in our practical dealings with the world we are living in and with each other. Separating out the facts (or what we believe to be the facts) and reasoning about them in relative isolation from other components of our minds seems to have survival value for an organism like us, given the level and character of our cognitive abilities. In other words, this is a cognitive pattern that provides us with evolutionary advantages, and that is why we have developed it.[2]

The separation of facts from values operates in our individual thought processes and we can assume that it contributes to our cognitive abilities as individuals. However, its importance appears to be even greater when we communicate with each other. Organized collective decision-making for instance in a court of law, a board of directors or a parliament is based on ways of discussing that depend on this separation.

It is against this background that we can understand the practical successfulness of science. Beings like us, who isolate the factual components of our thoughts, can communicate, deliberate, and co-ordinate with others much more efficiently if we have a large common ground in the form of a joint set of factual beliefs. This is what science does for us; it provides a common repository of reliable factual beliefs that we can all share.

3 A scientific corpus

The statements that are accepted by the community of scientists form a continuously changing corpus of science, or repository of scientific knowledge.[3] Some authors, notably Richard Jeffrey, have opposed the idea of a scientific corpus. According to Jeffrey, scientists should not accept or reject hypotheses. Instead, "the activity proper to the scientist is the assignment of probabilities (with respect to currently available evidence) to the hypotheses which, on the usual view, he simply accepts or rejects."

[2]This conforms with David Papineau's (2003, p. 40) proposal that theoretical rationality "piggy-backs on the evolution of cognitive abilities for 'understanding of mind' and for means-ends thinking".

[3]The use of the word "knowledge" in this context is not quite accurate since we normally assume that knowledge implies truth. The corpus consists of "justified provisional knowledge claims", but no sufficiently short term with that meaning is available. – In public discussions the scientific consensus is often hidden from view. False scientific controversies have repeatedly been created by enemies of the scientific consensus, e.g. creationists, tobacco propagandists, and deniers of climate science. (Oreskes & Conway, 2010) This gives rise to what Wendy Wagner (1995) called a "science charade" in which divergences in interests and policy viewpoints are camouflaged as differences in scientific opinion.

(Jeffrey, 1956, p. 257) To illustrate his standpoint, Jeffrey pointed out that a physician who decides whether or not to inoculate a child with a polio vaccine may very well come to another conclusion than a veterinarian who decides whether or not to use the same vaccine on a monkey. To accept or reject an hypothesis about this vaccine once and for all is "to introduce an unnecessary conflict between the interests of the physician and the veterinarian." (Jeffrey, 1956, p. 245) It is better that the scientist "contents himself with providing them both with a single probability for the hypothesis (whereupon each makes his own decision based on the utilities peculiar to his problem)."

As Jeffrey himself noted, this is a far cry from how science is actually conducted. What is worse, it does not even seem to correspond to a feasible way to conduct science. If we followed this recipe, science would be a vast, growing web of intricately interconnected hypotheses with probabilities greater than 0 but smaller than 1. This would make scientific reasoning and argumentation unmanageably complex. For instance, as was pointed out by McLaughlin (1970, p. 121), no reasonably simple account of measurement procedures would be available. Human cognitive powers are not sufficient to handle such a mass of uncertainty. Therefore, we have to take sufficiently plausible knowledge claims provisionally for certain.

We will have use for three important observations about the scientific corpus. First, *membership in the corpus is always provisional*. When we accept or reject empirical statements, we do not do so once and for all, come whatever may. We do not classify them as incorrigible, only as provisionally not to be doubted. This means that although we do not actively doubt them, we reserve the right to do so at a later point in time, should we learn something new that gives us reason for a reappraisal. The provisional nature of the corpus is one of the major reasons why science is more successful than its competitors. For instance, homeopathy is still based on principles from the late 18th century that were thoroughly refuted by discoveries in chemistry in the early 19th century. In contrast, scientific pharmacology has repeatedly been improved and revised throughout this period, largely in response to a long series of discoveries in chemistry.

Due to its provisional nature, the scientific corpus cannot easily be modelled with the tools of standard probability theory. In that theory the only way to express that a sentence is no longer doubted is to assign to it the probability 1. But once a statement has unit probability, it is immune to change and can never be put to doubt again. In this respect, belief revision models are more versatile since they allow us to retract full beliefs. (Hansson, 2010)

Secondly, *the scientific corpus is a general-purpose repository of knowledge*, not limited to any particular usage or application. This means that it is used both for all scientific purposes and for all practical purposes for which it is relevant. For example, we assent to the same statements about the chemistry of DNA irrespectively of whether we are studying human evolution, investigating ongoing speciation in the apple maggot fly (Xie, X. et al., 2007), performing laboratory diagnosis of hereditary diseases, or working with forensic DNA profiling. The general-purpose nature of the corpus is of course necessary due to our cognitive limitations. There is no chance that we would be able to deal efficiently with a multitude of corpora, one for each knowledge area.

Thirdly, *the scientific corpus has high entry requirements*. In science, the burden of proof falls to those proposing a new theory or claiming the existence of a previously unknown phenomenon. The high entry requirements are justified by the use of the corpus in further scientific investigations. Scientific progress can be seriously halted by the acceptance of false information, and therefore we should only accept new claims if we have strong reasons to believe them to be true. The high entry requirements are matched by fairly low exit requirements. If good reasons come up to doubt some element of the corpus, it should no longer be taken for granted but instead be subject to investigations aimed at clarifying its status.

The question that we started with can now be reformulated in a much more precise way: *Can the entry criteria for the scientific corpus be legitimately influenced by practical considerations?*

4 Conflicts between scientific and practical criteria

I hope to have shown that given our cognitive constitution, the use of a scientific corpus makes it possible to manage our knowledge in a much more efficient way than what we could otherwise have done. However, this does not make the corpus perfectly fitted for all practical decisions that we have to make. There are occasions when we want to take action based on a rather weak indication that something is the case. For instance, suppose that bacteriologists tell us that our drinking water contains bacteria that may be of either of two types. One of these types is quite toxic, whereas the other is innocuous. Presumably, most of us would want the authorities to respond to this information in the same way as they would if it were known with certainty that the bacteria are toxic – namely provide everyone concerned with safe water and strongly recommend them not to drink the tap water until definite information is available. However, in this situation a statement to the effect that these bacteria are harmful would not satisfy the requirements for corpus entry as delineated above. We therefore have a conflict between scientific and practical criteria for the evaluation of that statement.

The following examples can be used to investigate conflicts between scientific and practical criteria of acceptance.

> *The baby food additive*
> New scientific evidence indicates that a common preservative agent in baby food may have a small negative effect on the child's brain development. According to the best available scientific expertise, the question is far from settled but the evidence weighs somewhat in the direction of there being such an effect. A committee of respected scientists have unanimously stated that although the evidence is not conclusive it is more

> probable that the effect exists than that it does not. The food safety agency has received a petition whose signatories request the immediate prohibition of the substance.
>
> *Ski lift inspections*
> A new variant of stainless steel has been shown in laboratory tests to be amazingly resistant to the type of wear that is the main reason why the ropes of aerial lifts such as ski lifts are subject to frequent safety inspections. Articles about the new alloy have been published in the best journals, and its high wear resistance is considered by the best experts to be scientifically established. The first ski lift that uses wires of the new material is going to be built. Its owner asked the safety inspectorate for permission to reduce the frequency of rope inspections from once a month to once a year. His argument was that it has been scientifically established that the wire will be less abraded in a year than a traditional wire in a month. But the safety inspectorate did not grant this request.

In the baby food case, we have two crucial questions. First, should the food safety agency act as if it is known that the additive is harmful, i.e. prohibit or otherwise restrict its use? And secondly, should the scientific community make an exception from the standard requirements of corpus entry, and consider the toxicity of this additive to be scientifically established?

In my view, there are convincing reasons to answer the first question in the affirmative.[4] However, there are equally convincing reasons to answer the second question negatively. Taking it for settled that the substance is harmful can have various kinds of negative consequences. It would presumably lead us to refrain from further investigations aimed at finding out whether the substance really is toxic. This could potentially prevent us from discovering that the substance is harmless (and perhaps useful as a substitute for some other, harmful preservative in a product where a preservative is needed). It could also lead us astray in attempts to understand the relationships between neurotoxicity and chemical structure (thereby preventing us from making correct predictions about other substances). As these examples show, lowering the requirements for corpus entry could have negative consequences, not only for purely scientific investigations, but also for future practical decisions. To avoid this we should retain the high evidential requirements for scientific assent in spite of adopting lower requirements for the practical decision.

As far as I can see, this is also how such a case would normally be treated in practice. It is almost unthinkable for a scientist or a government official to say: "We have conclusive scientific evidence that the substance has these toxic effects, but we admit that it is almost equally likely that it does not." Instead it would be recognized

[4]Obviously, for the argument to go through it is only required that there are cases exhibiting this pattern, not that this particular example is such a case.

that even if the evidence for neurotoxicity is not strong enough to be scientifically conclusive it may be strong enough for a decision-maker to act *as if* the substance is neurotoxic.

In the ski lift example we have, correspondingly, the following two questions to answer: First, should the safety inspectorate reduce the frequency of safety inspections, or should a possible such decision be postponed until further evidence has been collected? And secondly, if the latter option is chosen, should the scientific community follow the authority in raising the standard of evidence and thus make the wear-resistance of the new material an open issue also scientifically, or should they maintain their previous assessment?

In answer to the first question I propose that the safety agency would be justified in requiring additional evidence although the standard scientific criteria of corpus entry have been met.[5] My answer to the second question is that it would be justified to raise the demands for corpus entry so that they coincide with those applied in the safety-critical practical decision. A distinction between two levels would be confusing in a case like this, since the lower of these levels would be the one usually indicating that there are no reasonable doubts in the matter. And importantly, raising the level of evidence required for corpus entry would not have the severe negative consequences that lowering the level could have. Therefore, it seems sensible to adjust the requirements for corpus entry upwards in this case.

What would happen in practice in a case like this? At any rate we should not expect safety inspectors to say: "There is conclusive scientific evidence that the wire has these properties, but we do not believe it." They would simply say that the evidence is not sufficient. This exemplifies a more general pattern: A claim that something is scientifically established but still has to be doubted has a distinctly paradoxical ring. This is of course because that which is scientifically established (included in the scientific corpus) is assumed not to be subject (at present) to reasonable doubt. Therefore we tend to raise the demands for corpus entry rather than introduce separate, higher demands of evidence for practical purposes.

The picture emerging from these two examples is a two-branched strategy for the influence of practical considerations on the requirements of corpus entry: When a practical decision demands a higher level of evidence than what is required for purely scientific purposes, then we tend to raise the demands for corpus entry accordingly. However, when a practical decision demands a lower level of evidence than what science *per se* would require, then we do not lower the demands for corpus entry. Instead, we maintain a distinction between two levels, one for the practical decision and one for corpus entry. If there is more than one practical decision to be made, then they may require different levels of evidence.

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[5]Again, the argument only requires that there are cases exhibiting this pattern, not that this particular example does so.

In my view, this two-branched strategy provides a much better account of the influence of practical values on scientific assent than approaches that do not distinguish between upwards and downwards adjustments of the requirements of corpus entry. The reader may well take this to be the main message of this contribution. However, to complete the picture some further complications need to be taken into account, mainly concerning the "purely" scientific requirements for corpus entry.

5 Conflicts between different scientific criteria

As noted above, the "purely scientific" requirements of corpus entry are high, primarily because much damage can be done to our scientific endeavours by the inclusion of false statements into the corpus. However, the extent of that damage to science is not the same for all statements that we may consider for inclusion in the corpus. It is useful to distinguish between two types of effects on science that may follow from the mistaken inclusion of a statement into the corpus.[6] First there are *direct epistemic effects* on scientific deliberations and other decisions on scientific assent. For instance, if we accept an incorrect statement about the strength of the jaw muscles of prehistoric predators, then this may lead us to draw incorrect conclusions about their diet and their role in the ecological system. Misdating an ancient text can induce us to draw erroneous conclusions about language development.

Secondly there are *indirect epistemic effects* on our scientific deliberations, by which is meant effects that are mediated by impacts on scientific investigations.[7] For example, if we conclude incorrectly that a certain island has always been uninhabited, then we will not perform archaeological investigations there. If we misidentify the conditions under which a phenomenon in particle physics will appear, then that may lead to a massive waste of money on experiments that provide no new information.

Let us now consider some examples of internally scientific considerations that at least seemingly call for adjustments in the criteria of corpus entry.

> *A new type of glass*
> A new type of glass makes it possible to produce thinner mirrors with the same quality and the same strength as traditional ones. Results showing that the new glass has these properties have been presented at conferences in materials science, and experts in glass science take this information to

[6]The distinction is related to that between theoretical and epistemic rationality. (Papineau, 2003; Kelly, 2003) Epistemic rationality is the rationality we exert when believing or disbelieving various statements, given the evidence that we have. Theoretical rationality is a wider concept that also includes other parts of our pursuance of cognitive goals, such as our decisions to perform actions that will provide us with information.

[7]The distinction between direct and indirect effects is not knife-sharp; indeed it cannot be more precise than the distinction between scientific deliberation and scientific investigation.

> be scientifically conclusive. A proposal has been made to use the new type of glass in a new space telescope predicted to cost several billion dollars. Due to the high economic stakes, the scientists planning its construction decide not to rely on the available scientific evidence that the glass has the desired properties, and therefore order new investigations.

This is a clear case of an indirect epistemic effect. For reasons paralleling those pertaining to the ski lift in the previous section, we can assume that the decision to reconsider the issue will not be expressed in terms such as "There is conclusive scientific evidence that the glass has these properties, but we are still not sure that it has". Instead, we can expect the decision to be justified by assertions that there are still reasonable scientific doubts in the issue.

> *Neutrinos travelling faster than light*
> In 2011 measurements were reported according to which neutrinos travelling from Cern to Gran Sasso in Italy had reached speeds higher than that of light in a vacuum. This result was met with much scepticism since if correct, it would overturn special relativity that is a cornerstone of physics and supported by an immense amount of empirical evidence. Much higher demands of evidence were applied to the validation of this experiment than what would have been applied to an experiment confirming that neutrinos do not exceed the speed of light. Arguably, the demands were indeed higher than those that would have been placed on almost any other physics experiment. (Overbye, 2011)[8]

Just as in the previous case, the scientific demands of evidence (i.e. the requirements for corpus entry) were raised. (It would have been almost unthinkable for physicists to say: "There is sufficient scientific evidence that these neutrinos travelled faster than light but we still doubt it." Legitimate doubt excludes scientific assent.) However, contrary to the previous case, this one represents a direct epistemic effect. The high demands on evidence in this case can be explained with reference to the common dictum that extraordinary claims require extraordinary evidence. (The common attribution of this phrase to David Hume is unsubstantiated, but what it says is compatible with his standpoints.)

> *A substance with uncertain effects*
> At a recent conference, a group of biochemists announced preliminary results indicating that a newly synthesized substance binds strongly to an enzyme, thereby deactivating it. These results were criticized by other researchers, and they are not considered to be sufficiently validated. Another research group is much in need of a substance that deactivates the enzyme in question. They decide to perform experiments with the new

[8] The result was soon shown to be an anomaly depending on deficiencies in the equipment. (Reich, 2012; Patrizii, L. et al., 2012)

substance in spite of the remaining uncertainty whether it actually deactivates the enzyme.

This is another example of an indirect epistemic effect. It is quite similar in structure to the example of the baby food additive in the previous section. The second group decides to act as if the substance in question is an inhibitor although there is insufficient scientific evidence that this is so. The value of performing exciting new experiments plays the same role here as the value of not exposing babies to a poison in the baby food case. The comparatively small disvalue of performing a few unsuccessful experiments plays the same role as the comparatively small disvalue of prohibiting an innocuous preservative in baby food. More importantly, in both cases the standard requirement of corpus entry is left unchanged. Instead of lowering it, a distinction is set up between the requirements for scientific assent and those for a non-epistemic decision (using the potential inhibitor respectively prohibiting the preservative).

These three examples can be classified as follows:

indirect effect, incentive to raise requirements (*A new type of glass*)
direct effect, incentive to raise requirements (*Neutrinos travelling faster than light*)
indirect effect, incentive to lower requirements (*An enzyme with uncertain effects*)

The three examples exhibit the same pattern that we saw in Section 4 for the influence of practical considerations: When there is a justification for raising the “standard” requirements for corpus entry, then this will be done. However, when there is a justification to lower them, then this is not done, but instead a separate lower level of requirement is established for the purpose at hand.

What about the fourth combination, “direct effect, incentive to lower requirements”? The standard requirements for corpus entry represent a level of evidence that we do not, for epistemic reasons, wish ever to go below. It is difficult to see how we could have epistemic reasons to lower that limit. Therefore, this fourth form of conflict between scientific criteria does not seem to exist.

6 A common but mostly implicit practice

In the previous two sections we have seen that the level of evidence required for scientific assent can differ significantly between statements that are candidates for such assent. This can also be exemplified with the levels of evidence required for claims on the effects of pharmaceutical drugs. Relatively little evidence is required before it is considered to be known that a drug has a serious side effect. Usually, a single, well-conducted study on patients taking the drug is sufficient. Much more evidence is required for a statement that a drug has no serious side effects.[9] For that purpose, extensive evidence from each of the phases of drug testing must be available, and this usually includes several independent, large clinical trials. Only if such evidence is available will the medical community consider the claim to be beyond reasonable doubt for both scientific and clinical purposes.

Notably, no distinction is made here between the scientific and the clinical criteria. This is a general pattern in medical science: The high demands of evidence that are justified in clinical medicine are assimilated into medical science, leading to correspondingly high demands for corpus entry in the medical part of the corpus of science. This is the reason why we never hear statements such as "From a scientific point of view we are confident that this diagnostic test gives the right answer, but we are still not sure that it does" or "We are not sure that this drug has the desired effect, but the scientific evidence shows conclusively that it does".

Decision-making in clinical medicine is imbued with values: values concerning the desirable state of the human body, the seriousness of various conditions, what risks it is justified to take in order to achieve various medical objectives, etc. In consequence, the criteria of scientific assent in medical science are also highly value-laden. However, this has usually not been seen as a problem since the values in question are with few exceptions uncontroversial. Most of the recent discussion on the impact of values in science has focused on controversial values.[10] Arguably, the largest part of that impact derives from uncontroversial values such as the value of health in medicine, functionality and safety in technology, efficient learning in pedagogical research, crime reduction in criminology, etc. We have a tendency to take these values for granted, and sometimes we may not even think of them as values. If uncontroversial values are taken into account, then the impact of practical values in science will be seen to be much larger than what has usually been assumed. (Hansson, 2009)

7 Conclusion

We have investigated the impact of values on the criteria for scientific assent or, in other words, the evidential requirements for a statement to be included in the scientific corpus. The picture that has emerged is somewhat more complex than most previous proposals, but I hope to have shown that it is also more accurate. It can be summarized as follows:

1. There is a bottom line for the evidential requirements for corpus entry, a bottom line that we never go below. Its level is fairly high, and it places the burden

[9] Strictly speaking, such a statement is inaccessible to empirical investigation. For purely statistical reasons, the best that we can obtain is evidence strongly indicating that the frequency of serious side effect is below some low but non-zero number. (Hansson, 1995, 1997)

[10] Note however, that the early discussion referred to uncontroversial values (Jeffrey, 1956; Rudner, 1953).

of evidence on those proposing a new theory or claiming the existence of a previously unknown phenomenon. The primary reason why the bottom line is high is that the introduction of false statements into the corpus can severely debilitate future research. If there are no other considerations at play then the actual evidential requirements will coincide with the bottom line.

2. We often have reasons to choose an even higher level than the bottom line. Such reasons may be either practical or theoretical. Including a false statement in the corpus may have negative consequences on our practical doings or it may be particularly damaging for our continued pursuit of science (over and above what the bottom line is intended to protect us against). In both cases, we solve this by raising the requirements for corpus entry to the higher level that is required.

3. There can also be both practical and theoretical reasons to apply, for some particular purpose, evidential requirements that are lower than the bottom line. In such cases, we introduce a separate standard for the purpose in question, and distinguish it from the requirements for corpus entry. We do not move the requirements for corpus entry below the bottom line.

I propose that this is an idealized but on the whole largely correct picture of how values in practice influence scientific assent. The epistemic strategy that it represents has the advantage of maintaining the *integrity* of science as a source of reliable knowledge. This is because we never go below a bottom line constructed to keep the influx of false statements into the corpus at a manageable, very low level. It also has the advantage of preserving the *unity* of science, since we have only one corpus, and all deviations from its requirements are dedicated to the solution of some particular decision problem.

The most important feature that distinguishes this model from previous ones is the distinction that it makes between movements upwards and downwards from the basic criteria of scientific assent. Another important feature is its uniform treatment of scientific and practical reasons for deviations from the bottom line requirements on corpus entry.[11]

[11] Heather Douglas (2009) also gave up the usual assumption that epistemic and non-epistemic values should be treated differently. Her criterion for acceptable influence of values on scientific assent is that values should only have an indirect role, and not directly influence the acceptance or rejection of hypotheses. The present approach allows values to have both direct and indirect influence, but in both cases they are only allowed to raise, not lower, the evidential requirements for scientific assent.

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