

## Is science like a crossword puzzle? Foundherentist conceptions of scientific warrant

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### ABSTRACT

This paper argues that the crossword puzzle analogy is great for scientific rationality, but not scientific warrant. It provides a critical analysis of foundherentist conceptions of scientific warrant, especially that of Susan Haack, and closely related positions, such as non-doxastic coherentism. Foundherentism takes the middle ground between foundationalism and coherentism. The main idea is that warrant, including that of scientific theories, is like warrant of crossword entries: the degree to which a theory is warranted depends on one's observations, the extent to which it coheres with one's other scientific theories and whether one's evidence includes a sufficiently large portion of the relevant evidence. I identify three problems for a foundherentist conception of scientific warrant, two of which are also problems for the image of science as a crossword puzzle. First, Haack's conceptions of personal and social warrant of scientific theories are incompatible. Second, the notion of warrant defeaters is crucial to any account of warrant, but foundherentism cannot accommodate certain warrant defeaters. Third, Haack's treatment of inconsistent evidence renders her account of social warrant for scientific theories implausible. Finally, I suggest that switching from the objective notion of warrant to the subjective notion of rationality might save foundherentism about scientific theories and the image of science as a crossword puzzle. I also draw lessons for social epistemology generally by applying the distinction between warrant and rationality to non-doxastic coherentism and Paul Faulkner's hybrid theory of testimonial warrant.

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### 1. Introduction

Some philosophers, such as Susan Haack, have suggested that doing science is like filling in a crossword puzzle (see especially Haack 1993, 120; 2001; [2003] 2007, 57–91; [1993] 2009). By scientific investigation, we fill in more and more

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entries. Each correctly filled-in entry corresponds to a true proposition. In comparing science with a crossword puzzle, Haack is in the company of Einstein ([1954] 1973, 295) and Kuhn ([1962] 1970, 36, 38). Einstein does not develop the idea into a theory at all and in Kuhn's work, the expression 'puzzle solving' is rather denigratory: it refers to what normal rather than revolutionary science does. Today, the idea that doing science is like filling in a crossword puzzle is often exploited in popular science magazines (e.g. Crease [2013]) and newspaper articles (e.g. Rafinski [1997]).

Unlike anyone else, though, Haack has developed the idea into a detailed epistemological theory of scientific warrant, which is the primary focus of this paper. As we shall see, our discussion also bears on other epistemological theories, such as non-doxastic coherentism, and more general issues, such as when it is warranted for a group of scientists to embrace a scientific theory.

According to Haack, a scientific theory is warranted to the extent that it fits the evidence. The way she construes 'fitting the evidence' differs from the two main epistemological theories about warrant, to wit foundationalism and coherentism. Applied to scientific theories, foundationalism says that a theory *T* is warranted if it is based on one's experiential evidence or observations (I use these words synonymously), or if it is somehow supported by theories that are based on one's observations. Coherentism, on the other hand, says that *T* is warranted if it sufficiently coheres with the other theories in the relevant field. Haack's view takes the middle ground between foundationalism and coherentism. On foundherentism, *T* is warranted to the extent that it fits the observations (analogous to the clues in a crossword puzzle) *and* is supported by one's reasons, i.e. one's other beliefs, including other scientific theories (analogous to filled-in entries). Like other philosophers (e.g. Sarkar [2007]), Haack distinguishes between the *personal* warrant of scientific theories (the warrant for individual scientists) and the *social* warrant of scientific theories (the warrant for groups of scientists).

The literature displays an extensive discussion on whether foundherentism is reducible to foundationalism or coherentism (e.g. Tramel [2008]). Several philosophers have defended Haack's foundherentism: Clendinnen (2007, 73); Ryan (2000, 79); Wójcicki (2007, 64, 67). Bonjour (1997, 19) finds Haack's foundherentism convincing for empirical justification and Walker (2007) indirectly defends Haack's account of warrant by elaborating her crossword analogy for warrant.

However, there has been no discussion of Haack's foundherentist account of *scientific warrant* and her idea that scientific warrant can be understood in terms of filling out a crossword puzzle. This idea is important, though, for one's account of scientific warrant makes a difference to which scientific theories one accepts and, hence, to how one construes the world. In this paper, I shall fill in this lacuna by evaluating Haack's twofold claim that foundherentism provides us with a good conception of scientific warrant and that scientific warrant can well be understood in terms of the clues and entries of a crossword puzzle.

My main thesis in this paper is that Haack's foundherentist theory of scientific *warrant* and the corresponding image of scientific *warrant* as a crossword puzzle are untenable, but that both foundherentism and the image of science as a crossword puzzle can be saved if they are taken to apply to a more subjective epistemic notion, such as *rationality*. I also show that the same applies to other, closely related epistemological views.

The paper is structured as follows. First, I briefly sketch foundherentism and explain the notions of personal and social warrant issuing from it (Section 2). Next, I identify three problems for Haack's foundherentist conception of scientific warrant, two of which are also problems for her image of science as a crossword puzzle. First, her conceptions of the personal and social warrant of scientific theories are incompatible. (Section 3) Second, Haack's view cannot accommodate certain kinds of warrant defeaters. (Section 4) Third, her treatment of inconsistent evidence renders her account of the social warrant for scientific theories implausible. (Section 5) Finally, I suggest that switching from the objective notion of warrant to the subjective notion of rationality might save foundherentism and closely related positions about scientific theories and the image of science as a crossword puzzle. I also draw some lessons for social epistemology generally by applying the distinction between warrant and rationality to non-doxastic coherentism and Paul Faulkner's hybrid theory of testimonial warrant. (Section 6)

## 2. Foundherentism and two kinds of scientific warrant

By 'scientific warrant', Haack means warrant for scientific claims or scientific theories. Haack's conception of scientific warrant is based on her conception of warrant in general, her so-called 'foundherentism'. Of what is this a conception? In her early work, she says it is a theory of 'justification', 'epistemic justification', 'warrant' or 'reasonableness', where she uses these words interchangeably. In her later work, however, she distinguishes between reasonableness or rationality on the one hand, which she takes to be a *perspectival* or *subjective* notion, and epistemic justification or warrant (see, for instance, Bo 2007, 23; Haack [2003] 2007), on the other, which she takes to be a more *objective* notion (for the distinction, see Haack 2001, 278). She takes her foundherentism to be a conception of *warrant*. (As we will see below, this will turn out to be crucial for our assessment of foundherentism.) In the epistemological literature, warrant is widely taken to be that which closes the gap between true belief and knowledge. See, for instance, Plantinga (1993); it seems that Plantinga's use of the word 'warrant' is widespread. This fits well with three clues in Haack's writings as to what warrant is:

- (1) our pre-analytic conception as 'good evidence, convincing reasons, acceptably-grounded belief';

- (2) an indication that the belief is true in the sense that it is likely to be true;
- (3) something that comes in degrees: a belief or theory can be better warranted than another.

It fits well in the sense that these three conditions are each necessary for warrant. They are not sufficient for warrant, for one is warranted only if one *bases* one's belief on the evidence in question and if an anti-Gettier condition is met. These three conditions give us enough grip on the notion to evaluate Haack's account of scientific warrant.

As I said, we should understand foundherentism in contrast with foundationalism and coherentism. Haack defines 'foundationalism' as the view that some-one's belief that *p* is warranted iff one's belief that *p* is (i) a warranted basic belief, i.e. based on the right kinds of experiences and warranted independently of any other beliefs, or (ii) warranted in virtue of its direct or indirect support by one or more basic beliefs. And she defines 'coherentism' as the view that one's belief that *p* is warranted iff one's belief that *p* belongs to a coherent set of beliefs.

In the epistemological literature, we also find certain views that are considered to be varieties of coherentism, even though they are closer to foundherentism on Haack's understanding of 'coherentism' and 'foundherentism'. Jonathan Kvanvig and Wayne Riggs, for instance, defend what they call 'non-doxastic coherentism'. On this view, a belief is justified or warranted, roughly, when it sufficiently coheres with one's beliefs *and* one's appearances states, sensation states and experiences (see Kvanvig and Riggs 1992, 197–202). They reply in detail to arguments by Donald Davidson and Laurence Bonjour to the effect that experiences cannot contribute to the justification of a belief. Like Haack, they often use the words 'justified' and 'warranted' interchangeably.

Kvanvig and Riggs do not provide a rigorous definition of non-doxastic coherentism. Their point is merely that non-doxastic coherentism offers important advantages over coherentism cashed out merely in terms of doxastic states. They argue that the assumption that justification is merely a matter of coherence among one's beliefs is an historic artefact that ought to be abandoned. Below, we will see what the ramifications of our discussion are for this position that is, clearly, closely related, even if not identical, to foundherentism.

Now, Haack's *Foundherentism* can be formulated as follows:

#### *Foundherentism*

*S*'s belief that *p* is warranted to the extent that (i) *S*'s belief that *p* is supported by *S*'s experiences and reasons, (ii) *S*'s reasons that support *S*'s belief that *p* are sufficiently warranted independently of *S*'s belief that *p*, and (iii) *S*'s evidence includes a sufficiently large portion of the relevant evidence. (See Haack [2003] 2007, 64)

Haack compares doxastic warrant with the warrant one has for filled-in crossword entries: the answer (one's belief that *p*) is warranted to the extent that:

- (i) it fits the clues (one's experiences) and the other entries that have been filled in (one's reasons, i.e. one's other beliefs);

- (ii) those other entries are themselves sufficiently supported by the relevant clues and other entries, independently of one's answer in question (those beliefs are sufficiently warranted, independently of the warrant conferred on them by one's belief that  $p$ );
- (iii) one has completed a sufficiently large part of the crossword puzzle (one holds enough relevant background beliefs and has enough relevant background experiences). (See Haack [2003] 2007, 67–68)

Haack stresses that the crossword image is not *just* an analogy: experiences, reasons and warrant relate to each other in the way clues, intersecting inked-in entries and one's warrant for a particular answer do (see Haack [2003] 2007, v–vii, 24; [1993] 2009, 126–127). Here, I will not discuss in detail how we should understand the support relation referred to in *Foundherentism*. Let me just point out that, according to Haack, how supportive evidence  $E$  is of  $T$  depends on (i) how much room  $E$  leaves for competitors of  $T$  (see Haack [1993] 2009, 127–128, 136, 278) and (ii) how well they fit together in an explanatory story (see Haack 2007a, vi; 2008, 269).

One may wonder whether Haack's *Foundherentism* is truly a rival to foundationalism and coherentism. For, as she defines them, foundationalism and coherentism are views about when a belief is warranted *simpliciter* – presumably, warranted enough to have *knowledge*. *Foundherentism*, on the other hand, concerns the *extent to which* a belief is warranted and implies that a complete account of the highest degree of warrant will have to take background experiences and reasons into consideration. That, however, means that adherents of foundationalism and coherentism could in principle embrace *Foundherentism*. A foundationalist, for instance, could say that being sufficiently supported by one's experiences is sufficient for one's belief's being warranted *and* that coherence with one's other beliefs *adds* to the degree of warrant. Here, I focus on whether *Foundherentism* is tenable as a conception of scientific warrant, whether or not it is truly a rival to foundationalism and coherentism.

Haack distinguishes several kinds of scientific warrant. The first conception is that of the warrant a scientific theory has for a particular scientist (what follows is my own formalization of Haack [2003] 2007, 60–80):

*Personal Warrant of Scientific Theories*

A scientific theory  $T$  is warranted for scientist  $S$  to the extent that

- (i)  $T$  is supported by  $S$ 's evidence, that is,  $S$ 's experiences and reasons,
- (ii) those reasons are sufficiently warranted independently of  $T$  and
- (iii)  $S$ 's evidence includes a sufficiently large portion of the relevant evidence.

*Personal Warrant of Scientific Theories* follows more or less straightforwardly from *Foundherentism*. The second conception is that of the warrant of groups of scientists, such as a particular research group, all physicists worldwide, or just any collection of scientist from different fields. In epistemology, there has recently

been a lot of attention for group warrant, including the warrant groups have for scientific theories (see, for instance, Faulkner 2004; Sarkar 2007; Wray 2007). Here is Haack's version of the social warrant of scientific theories:

*Social Warrant of Scientific Theories*

*T* is warranted for a group of scientists *G* to the extent that

- (i) *T* is supported by *G*'s evidence *E*, where *E* includes (a) those observations and reasons on which the members of *G* agree and (b) the disjunctions of those observations and reasons on which the members of *G* disagree,
- (ii) the reasons that the members of *G* have are sufficiently warranted independently of *T*,
- (iii) *G*'s evidence includes a sufficiently large portion of the relevant evidence,
- (iv) the members of *G* are warranted in trusting the reports about the observations and reasons of other members of *G* and
- (v) the communication among the members of *G* is good.

Again, this is my own formalization, based on Haack (2001, 169–170; [2003] 2007, 69–71).

A theory's warrant for a group of scientists differs from that for an individual scientist in two regards. First, since scientists disagree on certain issues and given that contradictions entail any proposition whatsoever, we cannot take the evidence of *G* to be the conjunction of all the observations and reasons of its members. Only where they do *not* disagree, we can take the relevant evidence to be conjunctive. Where they disagree, we will have to cash out the group's evidence in terms of a disjunction of their observations and reasons.

Second, since we are talking about *group* warrant, we have two additional conditions: the group warrant depends on the extent to which the members of the group are warranted in trusting each other's reports about observations and reasons, and there should be good communication among its members. I think Haack is right about this. The following example illustrates the point. In 1998, the firm Celera Genomics launched a privately funded project to map the human genome. It was a rival to the already existing publicly funded Human Genome Project, based primarily at the University of California, Santa Cruz. It is likely that, before their cooperation in 2000, there was some point in time *t* at which both groups, based on good research, had sequenced the relevant variations of the same gene. Let us call the theory that spells out the sequence of that specific gene  $T_1$ . Thus, at *t* both groups were warranted in accepting  $T_1$ . But it seems *false* to say that the members of the two groups jointly had *social* warrant for  $T_1$ . What seems right to say is that both groups each had their own social warrant for  $T_1$ , even if they had the same kind of evidence for embracing  $T_1$  – the same kinds of observations and the same kinds of reasons based on

those observations. Mutual trust and good communication, then, are necessary for a group's social warrant of scientific theories.

(A third conception that Haack puts forward is that of *impersonal* warrant of scientific theories. See Haack [2003] 2007, 71–72; [1993] 2009, 20, 134–135. However, she defines it in terms of personal and social warrant, so I focus on the latter two conceptions of scientific warrant.)

Below, we will see whether the above conception of social warrant for scientific theories is tenable. In doing so, we will take into account some of the recent literature on group knowledge and scientific warrant. We shall see that any foundherentist account of social scientific warrant along the lines of Haack's account runs into substantial problems.

### 3. Problem 1: the relation between social and personal warrant of scientific theories

Haack seems to be right that there is such a thing as the social warrant of scientific theories. Of course, there are controversial or at least contested cases. For instance, it is controversial that contemporary cosmologists are warranted in believing that we live in an ever-expanding universe. And it is still contested to which degree human-induced climate change will have a future impact. In other cases, though, nobody doubts that contemporary scientists have social warrant for the theories in question. Today's physicists are socially warranted in accepting Heisenberg's Uncertainty Principle and contemporary marine geologists in believing that there are hydrothermal vents in the Mid-Atlantic Ridge; virtually no one questions this.

Unfortunately, Haack does not say what it *is* for a theory to have social warrant – although, of course, she *does* give a particular account of when a theory has social warrant for a group of scientists. In order to assess *Social Warrant of Scientific Theories*, though, we need to have some idea of what social warrant is. Let me, therefore, suggest two conditions that are necessary for it. In doing so, I assume with most philosophers who work on social warrant, such as Gilbert (2000) and Mathiesen (2007), that it is something else than (or, at least, something over and above) warrant of all the members of the group.

First, in order for a group  $G$  of scientists to be *socially* warranted in accepting, believing or embracing  $T$  (I use these verbs synonymously), *at least most members* of  $G$  should be *personally* warranted in accepting  $T$ . If only a few members of  $G$  are warranted in accepting  $T$ , it is hard to see how the members of  $G$  as a group would be warranted in accepting  $T$ . If a minority group within  $G$  is warranted in accepting  $T$ , then it seems that *that minority* as a group is socially warranted in accepting  $T$ . Just to be clear: I do *not* say that most members of the group need to have made the relevant observations themselves. That, of course, would be a requirement that is hardly ever met. The point is that people can be *personally* warranted on the basis of the testimony of other members of the group – thus,

by mutual trust and good communication – about *their* observations and that a group is socially warranted in accepting a theory only if at least most of its members are warranted in accepting that theory.

Second, it is clearly not sufficient for a group of scientists to have social warrant for *T* that most or all of them are personally warranted in believing *T*. In order to have scientific warrant *as a group*, relations of *epistemic dependence* should hold among a substantial number of its members, as is widely acknowledged in the literature on group knowledge. This has been argued, for instance, by Faulkner (2004) and De Ridder (2013). The basic idea is that in cases of group knowledge, a significant number of the group members are personally warranted in accepting *T* only because other group members have evidence they do *not* have and because those other members share that evidence or, at least, enough of it. Thus, the group members are epistemically *dependent* on each other: if other members had not had that evidence or had not shared it with them, they would not have been personally warranted.

If these two conditions are necessary for the social warrant of scientific theories, though, Haack's foundherentist conception of personal scientific warrant is in trouble. For, these conditions jointly imply that in many cases of social warrant, the warrant of individual scientists depends on the observations and reasons of other scientists. In fact, given the complexity of scientific inquiry these days, it seems that *virtually all* cases in which a scientist is personally warranted in believing a theory are cases in which she is so because the group to which she belongs has social warrant for that theory. As Haack herself says: 'a scientist virtually always relies on results achieved by others, from the sedimented work of earlier generations to the latest efforts of his contemporaries.' (Haack [2003] 2007, 59) Haack's foundherentist conception of personal warrant, however, excludes the relevance of other people's observations and reasons to one's personal scientific warrant: whether some theory *T* is warranted for *S* depends solely on how well *T* is supported by *S*'s observations and reasons, on how warranted those reasons themselves are, that is, how well they fit with *S*'s other reasons, and on how much of the relevant evidence *S*'s evidence comprises.

Of course, *Personal Scientific Warrant* leaves ample room for *S*'s *beliefs* about other people's reasons and observations, and those beliefs of *S* may well be warranted. However, the point is that *Personal Scientific Warrant* does *not* require that those other people *actually have* those reasons and observations, whereas *Social Scientific Warrant*, in conjunction with the two plausible constraints about social warrant that I spelled out above, *does* require such a thing.

The same worry arises for epistemological theories close to foundherentism, such as non-doxastic coherentism, at least as long as they are understood as theories that provide both necessary *and sufficient* conditions for scientific warrant. For, that is not entirely clear in the case of non-doxastic coherentism since, as I pointed out above, non-doxastic coherentism has been suggested merely to argue against the assumption that coherentism should be understood entirely



in terms of beliefs and *not* in terms of experiences. A more modest version of doxastic coherentism would say that a plausible account of warrant appeals *at least* to a person's beliefs (other theories) *and* experiences (observations).

Let me give an example to illustrate this point against foundherentism. Today's community of physicists is *socially* warranted in accepting quantum mechanics. In virtue of observations and reasons of some scientists and maybe the good communication and mutual trust within the community of physicists as a whole, some individual physicist is *personally* warranted in accepting quantum mechanics. On *Personal Warrant of Scientific Theories* requires, though, all that is required for an individual physicist to be personally warranted in accepting quantum mechanics is that, say, she has read certain textbook accounts of quantum mechanics, warrantedly believes that all her colleagues embrace quantum mechanics and that this coheres well with her other beliefs. It does *not* require that other scientists have *actually made* the relevant observations and *actually have* the relevant reasons.

This point chimes well with some observations made in the literature on testimony. It has been argued that when it comes to *testimony* – something that is clearly indispensable for the warrant that scientists have for scientific theories – warrant is what Sanford Goldberg calls *socially diffuse*: whether a person is warranted in accepting a theory does not only depend on her own reasons and observations, but also on the warrant 'upstream' in the chain of communication, that is, the warrant that those who give testimony have (see Goldberg 2006, 120).

It follows that *Personal Warrant* and *Social Warrant* of scientific theories are incompatible with each other – at least, in conjunction with the two plausible constraints on social warrant of scientific theories that I specified. Haack could reject the first constraint, that *G*'s having social warrant for *T* entails that many members of *G* are warranted in accepting *T* because of the observations and reasons of other members of *G*. However, that not only seems implausible, but also hard to reconcile with *Social Warrant of Scientific Theories*, which implies that social warrant depends on the exchange of evidence within a group. And, as we saw, the second condition, which says that the members of *G* are socially warranted in accepting *T* only if their personal warrant depends at least partly on the reasons and observations of other members of *G*, seems to be entailed by *Social Warrant of Scientific Theories* itself.

Let us turn to Haack's image of science as a crossword puzzle. Does it suffer from the same problem? It does. In order to be relevantly analogous, the crossword puzzle would have to be such that the extent to which a specific crossword answer is warranted for a particular person depends not only on the clues for that entry, that person's other entries and how warranted those other entries are, and how much of the puzzle she has filled in, but also on the clues and entries of other people who are working on the same (enormous) crossword puzzle at the same time and of whose clues and entries she is or may be

unaware. If the warrant for a crossword answer depends on things that one is completely unaware of and if, therefore, one's clues and reasons are insufficient as indications of the truth, the image of science as a crossword puzzle falls apart. For, the most essential characteristic of crossword puzzles, namely the fact that warrant of entries depends on one's clues and one's other entries, has now been abandoned.

#### 4. Problem 2: scientific warrant and the role of defeaters

A crucial notion for any conception of warrant is that of *defeaters*. Defeaters are observations or beliefs that, unless themselves defeated, remove warrant for a belief. It is common to distinguish between *rebutting* and *undercutting* defeaters; see, for instance Pollock (1984, 113). A rebutting defeater for one's belief that  $p$ , is good evidence to think that  $p$  is false, whereas an undercutting defeater is good evidence to think that one's belief was unreliably produced. Slightly more formally:

##### *Rebutting Defeater*

$S$  has a rebutting defeater for  $T$  iff  $S$  has evidence  $E$  that is at least as strong as her evidence  $E^*$  for  $T$  and that implies that  $T$  is false.

##### *Undercutting Defeater*

$S$  has an undercutting defeater for  $T$  iff  $S$  has evidence  $E$  that is at least as strong as her evidence  $E^*$  for  $T$  and that implies that  $E^*$  is an unreliable indicator of the truth-value of  $T$ .

An undercutting defeater does *not* provide a reason to think that one's scientific theory is *false*, but a reason to give it up, that is, withhold judgement on whether it is true or false, until further evidence for or against the theory is discovered or the reliability of the evidential source has been re-established.

Clearly, any conception of scientific warrant that cannot take defeaters on board is untenable. Now, can the foundherentist conception of scientific warrant and the corresponding idea that science is a crossword puzzle take defeaters into account? I think there are *no* problems when it comes to *Personal Warrant* of Scientific Theories. Rebutting and undercutting defeaters undermine the support of one's reasons and, thereby, lower the degree to which a theory is warranted. As to the crossword image, rebutting defeaters can be seen as directly or indirectly intersecting entries that are well supported, or observations for directly or indirectly intersecting entries, or a combination of these, that imply that an inked-in entry is false.

Things are somewhat more complicated when we get to *undercutting* defeaters for personal scientific warrant. Let us take as an example Watson's theory  $T$  that there is cosmic microwave background radiation, his observation  $O$  of pigeon droppings on the antenna, and his ensuing belief that there are pigeon droppings on the antenna (call that proposition  $p$ ). It seems that

undercutting defeaters must be either clues, or filled-in entries, or a combination of these, for that is what crossword puzzles consist of. Clearly, *O* neither supports nor inhibits *T*. What about the other entries, then, such as Watson's belief that *p* and his belief that pigeon droppings rather than cosmic microwave background radiation might cause the noise detected? The problem is that those inked-in entries either (directly or indirectly) intersect with *T* or not. If they do *not*, they are irrelevant to *T*'s warrant. If they *do*, they either confirm *T* – *T* is one of the theories that fits the other entries – or they refute *T*, because *T* does not fit the other entries. But an *undercutting* defeater neither confirms nor refutes the belief in question.

I think the image of a crossword puzzle is flexible enough, though, to take undercutting defeaters on board with regard to *personal* scientific warrant. We could imagine, for instance, that the crossword puzzle is a digital one and that the place of clues can change depending on what answers one gives. The clues (the observations of detecting noise) still exist, but they are no longer clues for the entry that should be filled-in with the claim that there is cosmic microwave background radiation or with the claim that there is not. They are still clues for other entries, such as the entry with the answer that one detected noise, which is, after all, still a true proposition. I doubt that there actually are such crossword puzzles, but it is clearly *possible* to make them. (We should note, though, that it contradicts Haack's claim that the clues of the crossword puzzle are fixed to certain entries. See Haack [2003] 2007, 57–91. If we want to take undercutting defeaters on board, which any plausible account of scientific warrant requires, that claim has to go.)

Let us now turn to defeaters for *social* warrant. According to Haack, in determining whether a group of scientists have social warrant, we should consider (a) those observations and reasons on which they agree and (b) the disjunctions of those observations and reasons on which they disagree. I take it that 'to agree' should not be interpreted too strongly here, because it seems too demanding that all or most members of the group have to believe all the relevant reasons and have all the relevant reasons. It seems sufficient that they do *not disagree* on them.

Now, it seems possible for groups of scientists *not* to be warranted in believing *T* due to rebutting or undercutting defeaters. Imagine there is a group of scientists *G* consisting of two subgroups  $G^+$  and  $G^{**}$ . All members of *G* believe *T*. Communication within *G* is great; they share virtually all their reasons and observations and agree on them. However, there is one belief the members of  $G^+$  do not bother to share with the members of  $G^{**}$ , viz. their belief that *p*, because they do not consider it even remotely relevant to *T* and they do not regard *p* as evidence relevant to any problem the members of group  $G^{**}$  are working on. And, let us suppose that they are entirely rational in this.

There is also one belief the members of  $G^{**}$  do not bother to share with the members of  $G^+$ , viz. their belief that *q*, again, because the members of  $G^{**}$

do not consider it even remotely relevant to  $T$ . Again, let us assume that they are entirely rational in this. The conjunction of  $p$  and  $q$  happens to provide an undefeated defeater for  $T$ . Since, according to Haack, warrant is a matter of fitting the evidence, the group as a whole is *not* warranted in accepting  $T$ . But  $G$  meets all the conditions spelled out in *Social Warrant of Scientific Theories*. Hence, this scenario implies the falsehood of that conception of the social warrant of scientific theories.

One might try to meet this worry by revising the fifth condition as follows:

( $v'$ ) each member of  $G$  chooses to share all her observations and reasons *that directly or indirectly bear on the truth of  $T$*  with (most of) the other members of  $G$ .

Unfortunately, ( $v'$ ) will not do. For many scientific theories, there will be millions of observations and background beliefs that bear on the truth of  $T$ , such as each observation that confirms  $T$ . Surely, scientists are warranted in accepting  $T$  even if they do not share all of those observations and reasons. If we weaken the relevant clause by saying that they share *most* of the observations and reasons bearing on  $T$ , we are back to the original problem that there might be defeaters among the evidence, while sharing *all* one's observations is clearly impossible.

What about the crossword image? Can it take defeaters for social warrant of scientific theories on board? It cannot. If, on the one hand, the entries and clues of the crossword puzzle are the clues and entries that are shared and for which there is mutual trust, it is possible that there is mutual trust and good communication, but also an entry which has not been shared and, which, together with another entry which has not been shared, renders believing  $T$  unwarranted. If, on the other hand, we should think of the crossword as the aggregate of all the observations and reasons of the members of the group, then all sorts of theories can become warranted that might *not* be warranted, for instance, because there has been insufficient exchange or insufficient mutual trust within the group.

### 5. Problem 3: social warrant and inconsistent evidence

On *Social Warrant of Scientific Theories*, the evidence  $E$  that is relevant to  $T$ 's warrant for  $G$  consists of (a) those observations that the relevant scientists share and those reasons on which they agree, and (b) the disjunction of those observations and reasons on which they disagree. Of course, disagreement is rarely evenly divided. Nearly all physicists subscribe to the Big Bang theory of the origin of the universe, while a tiny minority still believes in the Steady State theory. And certain adherents of the Austrian School of economics subscribe to the Austrian business cycle theory, while most economists reject it. As Haack admits, this means that the degree of warrant corresponds to the proportion of disagreement. Evidence on which most scientists agree counts heavier for the social warrant of scientific theories than evidence on which only a few agree.

As Haack rightly points out, inconsistent evidence entails any proposition whatsoever. (Read: inconsistent *reasons*. According to Haack, experiences are

events, namely perceptual interactions between an individual and the world, and events do not have propositional content and, therefore, cannot be inconsistent with each other. See Haack [2003] 2007, vi, 63.) Thus, if we included contradictory evidence, then *any* theory would have social warrant. In order to avoid this absurdity, she specifies that all contradictory evidence should be excluded from the relevant evidence (see Haack [2003] 2007, 64–65, 122; [1993] 2009, 64, 128–129). A somewhat similar view is implied by Rolin (2010, 219, 224) when she claims that consistency in a set of views is necessary for a group's being justified in holding those views.

However, this gives rise to an important problem. Quantum mechanics and general relativity are incompatible, even though virtually all physicists accept both theories. Haack's view on inconsistent evidence implies that we should exclude both quantum mechanics and general relativity from the evidence base of groups of scientists. But, clearly, many theories and scientific beliefs are warranted precisely in virtue of theories such as quantum mechanics and general relativity. Of course, a substantial part of the evidence, such as many observations, that makes quantum mechanics and general relativity warranted would still remain part of the evidence if they were removed, but the remaining evidence would be insufficient to warrant many statements that we take to be warranted, precisely because they are supported by such universal theories as quantum mechanics.

One could reply that we should take quantum mechanics and general relativity theory separately and combine them with the remaining body of evidence with which it is compatible and *then* see whether the relevant theory is warranted by the evidence. But this will not do for at least two reasons. First, if we were allowed to remove any proposition from the evidence base that contradicts another proposition, we could simply exclude defeaters from the evidence base and thereby make virtually any scientific theory warranted.

Second, this move would imply that a single scientific theory is warranted to different degrees for the same group of scientists. If we remove quantum mechanics from the evidence, wave-particle duality has little warrant, but if we *do* take it into account, it has substantial warrant.

The problem of inconsistent evidence has been touched on by coherentists in providing a solution to the problem of incoherent justified beliefs. In the case of the Preface Paradox and the Lottery Paradox, for instance, we hold beliefs each of which, it seems, is justified, yet at least one of which is false. One important attempt to solve this problem can be found in the writings of William Lycan. According to Lycan, logical consistency *enhances* justification, but is not *necessary* for it. All that is required for justification is consistency, say, in subparts of one's total belief system. Lycan (1996, 10) even explicitly mentions general relativity and quantum mechanics as an example.

However, in order to be convincing, this response to the problem of inconsistent evidence would have to meet at least two difficulties. First, it would

have to provide a justification that is not ad hoc. Exactly why should we think that warrant depends on the consistency within a subset of one's beliefs and experiences if we had not had the problem of inconsistent evidence? Second, Lycan does not provide – and it is hard to come up with – a way to carve subparts of belief systems for which coherence *is* required at what seem to be natural joints (for similar criticisms of this approach, see Kvanvig [2012, 29–30]). This is not to claim that these worries cannot be met, but it is at least clear that more work has to be done here.

Jonathan Kvanvig has provided another solution. According to Kvanvig (2012, 30–40), we ought to distinguish between justified belief and *epistemically* justified belief, where only the latter puts one in a position to know and involves a legitimate closure to further inquiry. For example, in the lottery case, I am justified in believing that my ticket will loose, but I am *not* in a position to know that, because I have no justification for thinking that there is no further information that is not available to me that might undermine my belief that my ticket will loose.

Applied to the issue of inconsistent scientific evidence, the idea would be that we are *justified* in believing both the deliverables of research on the basis of quantum mechanics *and* the deliverables of research on the basis of general relativity, but *not epistemically justified* or *in a position to know* these deliverables. I think that this solution is promising. I return to it in the next section, in which I suggest an account of scientific warrant that provides a unifying solution to the problem of inconsistent evidence and the problems discussed in the two previous sections.

Remarkably, the crossword image fares much better on this point than Haack's *Foundherentism*. We can imagine that two large sections of the crossword puzzle have been filled-in, but that at some point where they intersect, the answers conflict. What one should do in considering an empty entry in the neighbourhood which directly or indirectly intersects with the answers that conflict with each other is clearly *not* to leave the inked-in entries out of consideration, but to take each of them into account and see how well different answers do on each of them. So, both in cases of disagreement and agreement, at least *some* contradictions should be taken as disjunctive evidence rather than be excluded from the body of evidence that confers warrant upon a crossword answer.

In the final section, I consider whether there is a solution to the three thorny problems that I identified, which saves something substantial of Haack's foundherentist conception of scientific warrant and the closely related image of science as a crossword puzzle.

## 6. Foundherentism, crossword puzzles, warrant, and rationality

I have argued that the foundherentist conception of scientific warrant provided by Haack faces three problems. First, it turns out that her conception of the social warrant of scientific theories is incompatible with her conception of personal scientific warrant. Closely related to this, the analogy of a crossword puzzle necessarily fails to take important features of the social warrant of scientific theories on board. Second, even though Haack's foundherentist conception of personal scientific warrant and her crossword image can deal with defeaters for *personal* warrant, they cannot incorporate some kinds of defeaters for *social* warrant. Third, certain cases of inconsistent evidence show that Haack's claim that inconsistent evidence should be excluded from the evidence base for social warrant is false. Fortunately, the image of a crossword puzzle does not suffer from this last problem.

How, then, should we diagnose the situation? I submit that, whereas Haack's foundherentism is meant to be an account of scientific *warrant*, it may in fact be an account of scientific *rationality*. Warrant and rationality are both epistemically valuable states, but they are crucially different.

Remember that warrant is that which closes the gap between true belief and knowledge, and which is truth-indicative in the sense that its being based on the observations in question and its cohering sufficiently with one's other reasons renders it likely that the theory is true. Rationality, however, is to believe in accordance with one's evidence as an epistemically responsible cognitive subject would do. As Haack ([2003] 2007, 77) herself says, scientific warrant is in this sense an *objective* matter, whereas scientific rationality is a *subjective* or *perspectival* matter.

It is quite common in the epistemological literature, including that on group rationality, to distinguish the more objective notion of *warrant* for certain beliefs (or theories) from the more subjective notion of *rationality* in believing certain beliefs or theories. A distinction along these lines can be found, for instance, in the writings of Fricker (2006, 32) and Mathiesen (2006, 165–166). Goldberg (2006, 2008, 174–199) also makes the distinction between a more subjective notion of rationality and a more objective one, where the latter entails that, in the case of defeaters (including external defeaters), one is sufficiently able to police one's belief for falsity.

I cannot defend my diagnosis in detail here. Let me show, though, how it solves the three problems that I identified for Haack's conception of scientific warrant. I start with Haack's foundherentist conception of warrant and then turn to her image of science as a crossword puzzle. After that, I consider what this teaches us about other theories of the warrant and rationality of embracing scientific theories.

First, *Foundherentism* may be plausible as a conception of personal scientific *rationality*, for whether someone is *rational* rather than *warranted* in embracing

a theory does *not* seem to depend on whether others have certain experiences or reasons, but only on her own reasons and experiences. What about *social scientific rationality*? We saw that *Personal Warrant of Scientific Theories* is incompatible with *Social Warrant of Scientific Theories*. One might suggest that we should, therefore, treat *Personal Warrant of Scientific Theories* as an account of rationality and *Social Warrant of Scientific Theories* as an account of warrant. This suggestion is implausible, though, for we saw that *Social Warrant of Scientific Theories* cannot take certain kinds of defeaters on board. In order to be a plausible account of warrant, it will need serious revision and I will not try to provide such revision here.

I, therefore, suggest to treat *Social Warrant of Scientific Theories* as a conception of scientific *rationality* after all, but to take its conditions to be merely *sufficient* for a group of scientists' rationally accepting *T*. The conditions spelled out in *Social Warrant of Scientific Theories* are not *necessary* for social rationality, since a group of scientists can be rational in accepting *T*, even though jointly they do not have enough evidence for *T*, e.g. because each of them is individually rational in accepting *T* and part of the evidence they have individually is due to the testimony of other members of the group.

Second, let us consider defeaters for social warrant of scientific theories. It seems that if a group of scientists *G* consists of two subgroups of scientists, and these subgroups exchange all their information and trust the members of the other subgroup, but fail to exchange respectively their belief that *p* and their belief that *q*, and the conjunction of these propositions provides a defeater for *T*, then they are *not warranted*, but nonetheless rational in accepting *T*. After all, since the members of the first subgroup deem *p* unimportant and the members of the other subgroup deem *q* unimportant – we can stipulate that they do so rationally – it seems perfectly rational for them to accept *T*, even though the total evidence of *G* indicates that *T* is false and, therefore, does not provide sufficient warrant for *T*.

Third, by excluding inconsistent evidence from the evidence base of groups of scientists, Haack rules out the warrant of some scientific theories, such as wave-particle duality. Of course, inconsistent evidence constitutes a conundrum for any rigorous epistemological theory of scientific warrant. All I have aimed to point out, though, is that *Haack's* solution, is untenable. Now, due to Haack's claim about inconsistent evidence, her conception of scientific warrant, as it stands, is also implausible as a conception of scientific rationality. After all, it is clearly rational for scientists to accept theories that are entailed or rendered sufficiently probable by quantum mechanics or general relativity theory.

As I noticed above, Jonathan Kvanvig, in defending non-doxastic coherentism, suggests that we distinguish between justified beliefs and *epistemically* justified beliefs, where in the latter case, one is in a position to have *knowledge*, whereas in the former case one is merely in a position to be justified in believing as one does. This squares well with the distinction I have made between warrant



and rationality. Warrant is that which closes the gap between true belief and knowledge, whereas rationality is something significantly weaker. Applied to the issue at hand, we would have to say – and that seems plausible – that scientists, both as individuals and as groups, can *rationally believe* the deliverances of scientific research based on quantum mechanics and general relativity, but that, as things stand, they cannot *know* these deliverances, since quantum mechanics and general relativity are incompatible.

We saw that the idea that scientific warrant can be understood in terms of a crossword image does not suffer from the third problem, whereas it does suffer from the first and second problems. What if we take the crossword metaphor as an image for scientific *rationality*? I think it does much better on this alternative approach. It can plausibly be argued that the rationality of an entry for a particular person depends on her clues for that entry, the answers she has already given, the clues for that, and so on. As to social rationality, it seems that it is rational for a group of scientists to accept *T* if each or most of its members are rational in accepting *T* and they are so because they are mutually epistemically dependent. Similarly, it is possible for a crossword answer to be rational only because it intersects in the right ways with conjunctions of other entries (the reasons of other people) and the clues for those entries (those people's observations).

What I have argued is not only relevant for Haack's *Foundherentism*. I already pointed out that non-doxastic coherentism will have to take some of the considerations I mentioned into account. But it is also relevant to other, closely related theories in epistemology. Take Paul Faulkner's hybrid theory of testimony. This is a theory about when an audience – a group of people – is warranted in holding a particular belief on the basis of testimony, which, presumably, includes a group of scientist's believing a scientific theory on the basis of the testimony of other scientists. Here is what he says:

I propose the following theory of testimony.

(A) An audience is warranted in forming a testimonial belief if and only if he is justified in accepting the speaker's testimony.

(B) If the audience is warranted in forming a testimonial belief, then whatever warrant in fact supports a speaker's testimony continues to support the proposition the audience believes. (Faulkner [2000, 591])

According to Faulkner himself, this theory is hybrid in the sense that (A) is internalist, whereas (B) is externalist. If what I have argued is right, this theory cannot be correct, for the following seems possible. A group of scientists is perfectly rational in believing a theory *T* on the basis of someone *S*'s testimony, say, because the group has good reason to think that *T*'s testimony is reliable. However, *T*'s testimony has a few features that the group is unaware of and the group has all sorts of reasons and observations that, in fact, provide a defeater for *S*'s testimony given those features, so that, even though *T* is warranted for *S* (because *S* does not have the reasons and observations of the group), it is not warranted for the group. Thus, (B) is false: it is *not* the case that if (A) is met

because the group is rational in accepting someone's testimony, the group is also warranted in believing that testimony if the testimony was warranted for that person. Thus, the distinction between rationally believing a theory and being warranted in believing a theory is crucial not only for foundherentist conceptions of scientific warrant, but also for other epistemological theories about when it is rational or warranted to believe a scientific theory, either as an individual or as a group.

I conclude that a plausible account of scientific *warrant* will differ substantially from Haack's *Foundherentism*, and that a plausible analogy for scientific *warrant* will *not* be that of a crossword puzzle. If they are to be relevant to the epistemology of science, they will have to be applied to other epistemic notions that are more subjective or perspectival, such as rationality.

## Notes on contributor

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