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THE RATIONALITY OF SCIENTIFIC REASONING IN THE CONTEXT OF PURSUIT: DRAWING APPROPRIATE DISTINCTIONS

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ABSTRACT

The aim of this paper is to disambiguate between different notions of pursuit worthiness regarding scientific inquiries. To this end we propose a unifying pattern of pursuit worthiness: "It is rational for Y to pursue X if and only if pursuing X is conducive of the set of goals Z." By showing in which ways variables X, Y, and Z can be changed, we present different notions of pursuit and pursuit worthiness. With respect to variable X, we distinguish the pursuit of scientific theories, epistemic objects, and technological developments. With respect to variable Z, we distinguish between epistemic and practical pursuit worthiness. Finally, with respect to variable Y, we distinguish between individual and communal pursuit worthiness. By means of these distinctions we are able to explicate some of the major ambiguities underlying the concept of pursuit of pursuit worthiness, as well as to shed light on some confusions in philosophical literature that have resulted from their neglect.

1. Introduction

In response to Hans Reichenbach's distinction between the context of discovery and the context of justification (Reichenbach, 1938), the so-called context of pursuit emerged as the context characterized by a preliminary evaluation of scientific theories (Laudan, 1977, 1980). This context combines the aspects of discovery (as the process of theory development) and the aspects of justification (since the normative question, whether a given scientific idea is worthy of pursuit, can be posed in it). In this paper we will primarily focus on the latter of the two aspects - the question of the pursuit worthiness of scientific inquiries.

A number of authors have identified the idea of pursuit worthiness and emphasized its importance for explaining the dynamics of science. For instance, we can find Richard Tursman speaking of "the logic of pursuit and/or of preliminary evaluation of hypotheses", linking it to Charles S. Peirce's account of abduction as a logic of pursuit (Tursman, 1987, p. 13-14). Imre Lakatos characterizes his "methodology of scientific research programmes" as consisting of "a negative heuristic", which tells us what paths of pursuit to avoid, and "a positive heuristic", which tells what paths to pursue (Lakatos, 1978, p. 47). Ernan McMullin speaks of a "heuristic appraisal", which regards the research-potential of a theory (McMullin, 1976). Thomas Nickles also discusses "heuristic appraisal" (Nickles, 2006), as well as a "preliminary evaluation", "plausibility assessment" or "pursuit" as the context which "requires the comparative evaluation of problem-solving efficiency and promise, not simply the evaluation of completed research", in contrast to the traditional theories of confirmation (Nickles, 1980, p. 21). Martin V. Curd argues that "not only is the logic of pursuit of more immediate practical relevance to scientific inquiry than the logic of probability but also that it is the only workable notion of a logic of discovery in the sense of a logic of prior assessment that one can formulate" (Curd, 1980, p. 204).

Moreover, it has been pointed out that the question of pursuit worthiness of scientific inquiries can be posed not only with respect to the young scientific theories, but also for those that are already accepted or those that have been overthrown (Nickles, 2006). Thus, in this broader sense, the evaluative aspect of the context of pursuit refers to the assessment of pursuit worthiness of scientific inquiries at various stages of theory development.

But how to characterize the rationality of scientific reasoning underlying this context? A general way to understand "*X* is worthy of pursuit" is in terms of goal-directed rationality, i.e. along the bi-conditional scheme:[1]

> It is rational for *Y* to pursue *X* if and only if pursuing *X* is (sufficiently/most/etc.) conducive of the set of goals *Z*.

By interpreting each of the variables *X*,*Y*,*Z* in a different way, we can obtain different notions of pursuit worthiness. First, the unit of evaluation (*X*) can be a scientific theory or some other scientifically relevant issue (such as an epistemic object or a technological development). Second, the

[1] We are here interpreting what might be considered epistemic rationality (i.e. "it is epistemically justified to consider X as worthy of pursuit") in terms of instrumental rationality (i.e. "it is justified to pursue X since it helps us in achieving a set of goals Z") (see (Kelly, 2003)). How these two notions of rationality are co-related in the case of pursuit worthiness is a discussion that goes beyond the scope of this paper. Then again, according to Wolfgang Spohn epistemic rationality only concerns "empirical beliefs about how the actual world is" (Spohn, 2002, p. 252), while evaluations (such as our evaluations concerning the pursuit worthiness of theories) belong to the realm of practical rationality. Spohn also criticized theories of instrumental rationality in which actions are the primary locus of rationality, whereas he prefers to focus on intentions instead. Of course, our scheme may readily be reformulated in view of this objection.

goals that a pursuit should be conducive of (*Z*) can be defined in various ways. Many of the philosophers mentioned above have regarded them as epistemic (or cognitive) goals, and thus treated the evaluation of pursuit worthiness in terms of epistemic (or cognitive) values. However, more recent discussions of pursuit have taken the perspective of practically relevant goals, where the evaluation in the context of pursuit consists of both epistemic and non-epistemic criteria (e.g. (Kitcher, 2001), (Douglas, 2009), (McKaughan, 2008), (Elliott and McKaughan, 2009)). Finally, we can take the subject for whom the pursuit worthiness is evaluated (*Y*) to be an individual scientist, a given scientific community, a certain interest group, etc.

The aim of this paper is to disambiguate between different notions of pursuit worthiness regarding scientific inquiries along these lines. This will help us to shed light on certain confusions in philosophical literature and on some important questions regarding scientific rationality that have remained insufficiently addressed. In Section 2 we will make some preliminary points concerning the interpretation of our scheme. In Section 3 we will discuss different units of appraisal. We will then in Section 4 address different types of goals and show in which way –what we shall call– epistemic pursuit worthiness differs from practical pursuit worthiness, where the former involves only epistemic goals while the latter involves both epistemic and non-epistemic goals. In Section 5 we will address the issue of the subject for whom the pursuit worthiness is evaluated and we will take a closer look at the distinction between –what we shall call– individual pursuit worthiness and communal pursuit worthiness. Moreover, we will show some important consequences of this distinction for the discussion on pluralism, and for the issue of consensus and dissent among scientists. Section 6 concludes the paper.

2. Some Preliminaries Concerning our Scheme

2.1 The evaluator, Y and Z

The evaluator and Y. It is important to distinguish between the person who uses the formula in order to evaluate the pursuit worthiness of some X –let's call her the evaluator– and the subject(s) Y for whom X is evaluated to be pursuit worthy.

Note further that the evaluator is always a single person while *Y* may be a group. Moreover, in case *Y* is a single person it may not be identical to the evaluator. In case *Y* is a group it may not contain the evaluator. A simple example is the application of the evaluation of pursuit worthiness as part of a historical rational reconstruction (see e.g. (Šešelja and Weber, 2012)), which discusses the question whether the theory of continental drift was pursuit worthy, or (Chang, 2011), which discusses whether phlogiston was pursuit worthy after the Chemical Revolution).

The set of goals *Z*, criteria, values, the evaluator and *Y*. Let us now specify how the set of goals *Z* relates to the evaluator and *Y*. First, in case *Z* is not part of *Y*'s set of goals there is no normative force to a claim of the following kind: *Y* should do some action *A* since doing *A* is conducive of the set of goals *Z*. Hence, the goals in *Z* have to be successfully ascribable to *Y*.[2] Second, *Z* and the associated values and criteria may be

[2] Of course, one may counter-factually ascribe some goals to Y irrespective of the question whether Y actually has these goals. However, in this case we do not evaluate the rationality of Y but rather the one of a counter-factual counterpart of Y.

independent from the evaluator's goals, values and criteria: e.g. an ethical constraint to avoid vivisection may be ascribable by some evaluator to *Y* although the evaluator herself doesn't share this value. Third, the criteria and values used in order to evaluate the conduciveness of *X* for *Z* are either those that the evaluator considers as apt, respectively best for the evaluation or those that the evaluator ascribes to *Y*. For instance, in a historical rational reconstruction we may, on the one hand, evaluate the pursuit worthiness with criteria and values that reflect the methodological standards of the respective time period. On the other hand, we may notice certain epistemic biases present in the values used by scientists, and hence approach the issue in a more corrective and critical manner, by introducing standards that we conceive of to be more conducive of the goals recognized by the scientists at the time.

2.2 Types of evaluation

In this section we will discuss and disambiguate the right side of our bi-conditional scheme, namely "X is conducive of".

Comparative reading. One way of reading this phrase is in a comparative manner. Given a set of candidates the evaluator is interested in the theories that are –individually judged– the comparatively most conducive of Z. One may think about this type of evaluation in terms of optimizing: the evaluator seeks the theories that optimize the likelihood of reaching the set of goals Z. However, it is important to notice that it may sometimes be impossible to order theories in a linear order of preference according to their pursuit worthiness, hence there may be various mutually incomparable candidates that are best and hence judged

to be pursuit worthy, while there is not the best one.[3] On the one hand, the reasons for this can be found in the usual suspects forwarded by the proponents of bounded rationality: the limitations of our cognitive powers, the limited time we have for our evaluations, etc. On the other hand, when dealing with evaluations based on multiple criteria –e.g., C_1 and C_2 – we usually end up quite naturally with partial as opposed to linear orderings. Just suppose T_1 fairs better with respect to C_1 than T_2 while T_2 fairs better with respect to C_2, and suppose further that we do not prefer C_1 over C_2 nor vice versa. In this case T_1 and T_2 are incomparable.

Note further that the optimizing concerns the variable *X* in our formula as opposed to *Z* and the associated criteria and values. The questions: (a) which criteria are optimal in evaluating the pursuit worthiness of a theory, and (b) which goals are the intrinsic, essential, or indispensable values of *Y* (e.g., the scientific community) are independent from the former and –although being an appropriate puzzle for the philosopher of science– beyond the scope of this paper.

One peculiarity for this type of evaluation is that it is not aggregative in the following sense. It may, for instance, be the case that the evaluator ends up with theories T_1, T_2 and T_3 that are deemed pursuit worthy for *Y* (since each of them is maximally pursuit worthy compared to the other candidates), however it would not be rational for *Y* to pursue all 3 candidates. For instance if *Y* is a single scientist it may be more efficient for her to focus on one theory, or if *Y* is a research centre the given resources may restrict the choice to say two projects.

The latter example motivates another comparative modus of evaluation. Given our set of candidates the evaluator is now interested in the subset of candidates that are comparatively most pursuit worthy,

[3] Hence, when we speak of "optimizing" we have a heuristic, respectively bounded notion in mind rather than the strict and often futile search for the singular optimal candidate.

judged as a "research package". In contrast to the first modus here *X* need not consist of a single theory. Note that, similar as above, in some cases it may not be possible to linearly order the various subsets of candidates according to their respective pursuit worthiness. We may also think of this type of evaluation in terms of optimizing: the evaluator now seeks the set of candidates, the pursuit of which optimizes the likelihood of reaching the set of goals *Z*.

A small example helps to illustrate our point: Suppose that judged individually our evaluator considers T_1 and T_3 more pursuit worthy than the still rather promising T_2, and T_2 more pursuit worthy than the bad candidate T_4. It is not clear which theory, T_1 or T_3, is comparatively more promising. So from the point of view of the individual comparative type of evaluation T_1 and T_3 are most pursuit worthy. Now suppose further that each of our four candidates individually can be financed by *Y*, however T_3 being the most expensive of all is such that it would itself consume all the financial resources available to *Y*, while it is possible to financial support the bundle T_1 and T_2. In this case the latter subset $\{T_1, T_2\}$ is preferred over $\{T_3\}$ and may be indeed the most pursuit worthy in the second comparative type of evaluations where *X* is a bundle of theories.

Non-comparative reading. Finally, there is a non-comparative type of evaluation. In this case, when we evaluate the pursuit worthiness of theories we do not compare their overall respective pursuit worthiness in order to decide whether they are promising candidates. Rather, the evaluation concerns intrinsic factors which make it possible to judge the pursuit worthiness of a given theory irrespective of how other theories perform in terms of pursuit worthiness.[4] Of course, this does not mean that the evaluation is entirely ignorant with respect to other theories.

[4] See also (Whitt, 1990).

Rather, the explanatory scope, the open questions and problems of other theories, etc. constitute the cognitive horizon against which the pursuit worthiness evaluation takes place. More precisely, the cognitive horizon is constituted –among other things– by the current subject domain of a given discipline, by the problems that scientists tackle, by the anomalies and difficulties they face, by respected scientific methods, etc. The cognitive horizon need not be homogeneous: various sub-disciplines may have different preferences e.g. on what counts as a good scientific method, a good explanation etc. Moreover, a newly pursued theory may challenge this status quo in some ways. Many of these points are constituted by other, maybe rivaling theories. For instance, one of the indices of pursuit worthiness can be formulated as the question whether the theory is able to offer certain novel explanations or predictions, that is, to explain or predict phenomena that its rival is not able to. Hence, we may have to compare certain features of the new theory with those of its rivals. However, that does not mean we are comparing their overall epistemic or cognitive promise.

In this type of evaluation the phrase "is conducive of" is interpreted in terms of constraint satisfaction where the given criteria and values determine a certain threshold against which the evaluation of X takes place. If X is judged to be more promising than the threshold, X is deemed to be worthy of pursuit.

Static versus dynamic rationality We sometimes give examples where we speak of a group or organization (such as a research center) evaluating the pursuit worthiness of some *X*. However, as pointed out above, this rather imprecise formulation should not distract from the fact that the evaluator is always a single person. Typically, many experts in the organization will individually be evaluators and communicate their results and enter thereby a process of rational negotiation about the pursuit worthiness of *X*, which may in turn make some experts go through a process of several readjustments of their evaluation. This may take various forms: on the one hand, informed by their peer experts they may

revise some of their evaluations and/or criteria used for the evaluation and hence adjust the outcome of the evaluation accordingly. On the other hand, other experts may convince them that some of the goals they have ascribed to *Y* are inappropriate and they will adjust them accordingly. This dialectic deliberation process is also typical in scientific debates concerning the pursuit worthiness of scientific theories. Sometimes this may lead to consensus formation, sometimes dissent will ensue.[5]

Against the background of this discussion it is important to notice that our notion of rationality is a *static* one.[6] It concerns the question whether it is rational to pursue *X* given the best current insights on the basis of the given goals and criteria. This is different from a *dynamic* evaluation that concerns the question whether the evaluator arrived at the present stance in a rational way. This may for instance lead to a critical rational analysis of the dialectical deliberation process we discussed in the previous paragraph.

3. The Pursuit Worthiness of Theories, Epistemic Objects, and Technological Developments

In this section we will clarify different types of pursuit our discussion is concerned with (variable *X*). We can distinguish between the pursuit of

[5] How a consensus regarding pursuit worthiness may be concretely achieved remains a topic for future research (see, e.g., (Gilbert, 1987), (Beatty & Moore, 2010)).

[6] For the distinction between static and dynamic rationality theory see e.g. (Spohn, 2002).

scientific theories and other types of pursuit, such as those regarding epistemic objects or technological developments.[7] These types of pursuit are often interwoven or come in bundles within the same research. For instance, the pursuit of Wegener's theory of the continental drift, which was explanatory of different geological explananda, implied the pursuit of the continental drift as an epistemic object. Therefore the pursuit worthiness of the theory of continental drift implied that the continental drift as an epistemic object was worthy of pursuit as well.

As it has often been pointed out, how promising a given theory is, needs to be assessed by means of a set of criteria that is different from the one used for assessing theory acceptance ((Laudan, 1977), (Whitt, 1992), (Šešelja and Straßer, 201x)).[8] Different authors have emphasized different values as indices of pursuit worthiness, but explanatory and heuristic virtues of the given theory have often been considered as some of the crucial ones. For instance, the capability of the theory to offer explanations that its rivals have not managed to offer so far can be seen as such an indicator. This explanatory virtue is different from the one usually required for theory acceptance, where we are not only interested in what the theory can explain, but also in what it cannot explain, that is, in its explanatory anomalies. In contrast, when we evaluate whether a theory is worthy of pursuit, instead of focusing on its explanatory anomalies, we are rather interested in its programmatic character. That is, we are interested in the prospective values, which allow for a prospective assessment, rather than a retrospective one, which is typical for the

[7] This distinction is different though complementary to Martin Carrier's distinction between knowledge-driven research and demand-driven research (Carrier, 2010).

[8] A similar distinction can be made for the acceptance of an epistemic object/a technology as opposed to the question whether it is pursuit worthy.

context of acceptance. (see (Šešelja and Straßer, 201x), (Whitt, 1992, p. 621), (Whitt, 1990, p. 472-473)).

In contrast to scientific theories, we can also speak of pursuit worthiness of epistemic objects. Hasok Chang (following (Rheinberger, 1997)) characterizes epistemic objects as entities that are identified as constituents of reality, and which have historicity about them (examples would be oxygen, phlogiston, atom, etc.). The interesting aspect of the historicity of epistemic objects is that some of them persist through theoretical changes, while others go extinct. Using the example of phlogiston, Chang argues that scientists sometimes abandon certain objects without having good epistemic reasons for that, and that moreover, there has been an unwarranted and unproductive tendency towards such eliminations (Chang, 2011, p. 426). In other words, these abandoned epistemic objects were worthy of pursuit. The question of the pursuit worthiness of epistemic objects is different from the question of the pursuit worthiness of scientific theories also due to the fact that the former can outlast different theories and conceptual frameworks.

In addition to the above mentioned historical examples of epistemic objects, a certain statistical correlation can be considered as an epistemic object as well. For instance, pursuing correlations such as those between smoking and lung cancer can be worthy in view of certain epistemic and social reasons. However, once we have shown that (or while we are investigating whether) the correlation holds, we are also interested in a theory that explains it. Whether such a theory is worthy of pursuit or not needs to be evaluated in a different way (for instance, by taking a look at the significance and the quality of those explanations that the theory offers, how well connected it is with other scientific theories, which heuristic methods the theory is based on, etc.).

Another example of the pursuit of epistemic objects is the investigation of the question as to whether there is extra-terrestrial life, as it has been done by various SETI (the Search for Extraterrestrial Intelligence) projects. For this investigation to be worthy of pursuit, we

need to show that there is a methodology that provides the heuristics of the investigation, that there is a certain level of likelihood of success in finding the extraterrestrial intelligent life forms, as well as that the overall epistemic and non-epistemic benefits of such an investigation outweigh the possible dangers (see (Kukla, 2001)).

Yet another type of pursuit that should be distinguished from the pursuit of explanatory theories is the pursuit of technological developments. Pursuing the invention of an instrument, apparatus, machine, etc. could be a part of the pursuit of a certain explanatory theory. For instance, developing nuclear weapons can be seen as a part of the pursuit of theories within the domain of nuclear physics, where the former was not only an application of the latter, but it also served to produce additional evidence for it. Clearly, there are good reasons why the pursuit of such a technology may be considered highly ethically problematic and in so far unworthy of being conducted. But this does not mean that a pursuit of theories in the domain of nuclear physics is unworthy as well, in case they offer alternative ways of obtaining the evidence regarding their hypotheses. When we evaluate whether a given technological development is worthy of pursuit, we are interested in how useful such a technology could be, how easy it would be to handle it, what the benefits and dangers of such a pursuit are, etc. In contrast to scientific theories, technological developments do not need to aim at offering scientific explanations (though they may indeed make use of scientific explanations that serve as guidelines in the construction of the given technology).

To sum up: on the one hand, the pursuit of phenomena, entities, and technological developments, and on the other hand, the pursuit of explanatory theories belongs to different types of pursuit, which may be tightly connected. Nevertheless, evaluating their respective pursuit worthiness may require different criteria of evaluation.

4. Epistemic and Practical Notions of Pursuit Worthiness

In this section we will focus on variable *Z*, the set of goals that a pursuit should be conducive of. It is clear that scientific inquiry concerns certain epistemic or cognitive goals, such as, providing explanations and accurate descriptions of natural or social phenomena, which should help us to better understand the world, or generating and consolidating theories "that express empirically grounded and well confirmed knowledge and understanding of phenomena" (Lacey, 2009, p. 840).[9] However, scientific inquiry as a part of the scientific practice may concern a broader spectrum of non-epistemic (or non-cognitive) goals as well, such as ethical, social or political goals. Hence, the pursuit worthiness of scientific theories may be evaluated in terms of epistemic or cognitive criteria, or in terms of a broader set of criteria that include also other, non-epistemic or non-cognitive ones.[10]

Some of the early approaches to the context of pursuit regarded pursuit worthiness primarily in terms of the former set of goals (e.g.

[9] Note that Lacey adds a number of other conditions that are constitutive of his account of the aim of science.

[10] Some authors (e.g. (Laudan, 2004)) make a sharp distinction between the notion of "epistemic values" and the notion of "cognitive values", since they interpret the former as values that are to be conducive of truth as the main epistemic goal. However, we take the notion of epistemic value in a less strict sense by leaving the issue of a concrete (set of) epistemic goal(s) open, that is, whether it, is to be specified as truth, empirical adequacy, coherence, etc. (see also (Lacey, 2004), ((Šešelja and Straßer, 201x)). Hence, for the purposes of this paper it will suffice to use the terms "epistemic value" and "cognitive value" interchangeably.

(Laudan, 1977), (Whitt, 1992)). However, a number of more recent discussions have related the evaluation of pursuit worthiness to the latter set of goals, that is, to a joint set of epistemic and non-epistemic criteria.

Practical Pursuit Worthiness We speak about *practical pursuit worthiness* where the set of goals *Z* comprises both epistemic and practical goals. Practical goals and values enter the picture, for instance, in the context of science policy. Ethical values may for instance give rise to restrictions on free inquiry:

> Respecting rights comes at a price, and it's important that the price be distributed fairly. In situations where free inquiry would unfairly increase the burden on those who are already disadvantaged, there can be no right to free inquiry. (Kitcher, 2009, p. 103)

Kitcher proposes a detailed account of how a scientific inquiry should be organized, where the notion of pursuit is understood in terms of both epistemic and non-epistemic standards (Kitcher, 2001, Chapter 9).[11] However, he recognizes a possible conflict between epistemic and non-epistemic reasons for pursuit worthiness.

Without going into a discussion on Kitcher's view on free inquiry, there is an important point about pursuit that Kitcher raises here. The conflicting interests regarding pursuit can be presented in terms of different prices that need to be payed if the pursuit is conducted. For instance, if the research involves a certain ethically problematic methodology, we may say that the ethical price to pay is too high, and

[11] Another example would be Heather Douglas' discussion of cognitive and non-cognitive values that jointly play a role in assessing pursuit worthiness of research processes (Douglas, 2009, Chapter 5).

hence, the pursuit in this form should be avoided. Similarly, we may ask whether the epistemic price to pay is too high if a certain pursuit (that is, a scientific project involving it) is no longer financed. The epistemic price could, for instance, refer to the abandoning of this research altogether, or to giving up on certain aspects of it, which would, if realized, result in an epistemic benefit. Those arguing for the rejection of further financial support may say that the economic price to pay outweighs the epistemic benefit in case the theory is pursued (for example, due to the fact that the theory is epistemically not very interesting, while its pursuit requires a huge investment). Of course, how one weighs and compares different "prices to be paid" is also dependent on social and political interests that determine what means that some factors outweigh the others, which can vary from one community to another. Hence, in some contexts non-epistemic criteria could outweigh the epistemic ones.

Epistemic Pursuit Worthiness. The *epistemic pursuit worthiness* concerns the case in which *Z* is restricted to epistemic goals.

This, in general, does not mean that the values used in this assessment have no pragmatic elements. For instance, in order for a theory to be pursuit worthy we may request that it is, in principle, technically realizable. Technical realizability is a criterion that obviously has a pragmatic aspect to it. This criterion concerns the feasibility of a research and its methodological requirements in view of the current technological achievements, and it is directly linked to the heuristics or programmatic character of the given research. It concerns the question as to whether the heuristics of the theory allows for further evidence to be collected and used to support the given hypotheses or to confront them with possible anomalies. Nevertheless, it is epistemic in character since it is conducive of the epistemic goals of scientific investigation (for example, its problem-solving efficiency). More precisely, unless the research is technically realizable, it cannot have a proper heuristics, which is one of the key epistemic requirements in the evaluation of pursuit worthiness

(see, for example, (Whitt, 1992), (Šešelja and Straßer, 201x)). These practical considerations that come with the heuristic appraisal of theories have been discussed by Thomas Nickels. The heuristic appraisal "evaluates the promise or potential fertility and feasibility of further work on a problem, research program, theory, hypothesis, model, or technique" (Nickles, 2006, p. 159) where "external factors" such as "whether […] research is likely to be funded, whether the lab director or department head will look favourably upon this project; whether enough laboratory space, equipment, and expert technical assistance is available" (p. 169) has to be taken into account. What distinguishes these practical considerations e.g. from the moral values discussed in the context of practical pursuit worthiness, is that they are in function of epistemic goals.

However, there are certain cases in which it is useful to suspend with certain practical considerations concerning the theory heuristics. Let us give two examples.

First, suppose some funding organization is interested in the pursuit worthiness of a theory for some research group *Y* in order to decide whether it wants to fund the research. Of course, the very decision whether the practical constraints of the theory heuristics are fulfilled depends on the funding and hence on the outcome of the evaluation itself. In this sense it would be circular or nonsensical to use as a criterion for the evaluation the likelihood of its funding by this organization. Rather, the funding organization is interested in questions, such as, whether the heuristics is promising under the counter-factual assumption that they would fund it.

Second, often it is interesting to abstract away from certain trends in research policy and funding. For instance, there may be a pragmatic turn in research policy which makes e.g. a fundamental research in cosmology or projects such as the above mentioned SETI program less likely of being funded. One may want to evaluate its pursuit worthiness by counter-factually suspending this practical constraint. A research program

may have a promising programmatic character (e.g., from a strictly methodological point of view) irrespective of the contingent external fact that its subject matter is currently not favored by funding organizations. Again, the evaluation takes place in a counter-factual manner.

Of course, there are certain factual considerations for which it would be nonsensical to counter-factually suspend them. This concerns, for instance, technical requirements in the heuristics of a given theory (such as computational power, experimental technology, etc.) that are (principally speaking) not available or the construction of which is impossible. However, where we draw the borderline is dependent on the specific context in which we evaluate the pursuit worthiness of inquiries.

It is also worth mentioning that non-epistemic considerations may function as factors in view of which the epistemic values are applied in case of epistemic pursuit worthiness. For example, if we want to assess whether a theory has exhibited a certain growth, which would help us in judging whether it has remained worthy of pursuit, we will have to take into account the number and the expertise of scientists working on the theory or the appropriate funding that allows for the required resources. That does not mean that the epistemic evaluation is not epistemic in character (we are still evaluating the epistemic growth of the theory). It just means that our expectations regarding the epistemic standards are in this sense context dependent. In other words, the non-epistemic factors determine in which respects the conditions for fulfilling the epistemic standards have been met, and what thus can be expected from the given theory.[12]

[12] We can here adapt Hugh Lacey's point on the interplay of cognitive and social values regarding theory acceptance (Lacey, 2005) to the context of pursuit: non-epistemic values form conditions under which epistemic appraisal (in the context of pursuit) occurs, though they are not constitutive of such an appraisal.

The significance of the distinction between epistemic and practical pursuit worthiness. Altogether, the main significance of distinguishing epistemic from practical pursuit worthiness is that it allows us to focus on the epistemic properties of an inquiry.[13] On the one hand, this is important for the evaluation of certain episodes from the history of science and the rationality underlying views of scientists with regard to the pursuit of certain theories. For example, if the pursuit of a theory was rejected due to some epistemic reasons, we will be interested in assessing whether such reasons were legitimate or whether the theory was, in fact, epistemically worthy of pursuit. On the other hand, the epistemic approach may help us in clarifying the reasons why a certain pursuit is favored or rejected. For instance, it could be found out that a pursuit of a certain theory is supported because of certain political reasons (and thus considered as practically worthy of pursuit in the second sense that we have explicated) in spite of being epistemically not very attractive. Similarly, a theory may be practically not worthy of pursuit while being epistemically worthy of pursuit. In this case we may want to focus on the suboptimal practical aspects of the theory. If for instance its experimental methods are ethically questionable we may want to revise and improve on the heuristics in view of these aspects (by e.g. investigating the question as to whether computational models can be used for similar purposes).

Finally, note that if the practical pursuit worthiness is to be epistemically responsible, epistemic pursuit worthiness is a necessary (though not a sufficient) condition for the practical one.

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[13] It is important to notice though that in some types of inquiries, such as those within the field of applied science and technology it may not always be possible to make this distinction, since the values may be essentially interwoven. For instance, what counts as a "successful" development of a given technology may depend on certain social and ethical constraints (see e.g. (Lacey, 2009)).

5. Individual and Communal Pursuit Worthiness

5.1 Individual and communal pursuit worthiness as a research directive and an evaluative stance

Finally, let us take a look at our third variable (Y), referring to the subject for whom the pursuit worthiness is evaluated. As we have mentioned in Section 1, this could be an individual scientist or a group of scientists (representing a certain scientific community). In view of this, we can distinguish between two types of pursuit worthiness. On the one hand, saying that a theory is worthy of pursuit for a given scientific community means that it is in the (epistemic and/or practical) interest of the given scientific community to pursue it. We will here focus on a particular meaning of the scientific community - namely, as referring to a group of scientists who are working in the given scientific domain.[14] On the other hand, we can speak of pursuit worthiness that refers to the (epistemic and/or practical) interests of an individual scientist. We will call the former communal pursuit worthiness, and the latter individual pursuit worthiness.

First of all, let us notice that even though an individual scientist belonging to a given scientific community usually upholds the communal

[14] Indeed, the notion of communal pursuit worthiness depends on which type of scientific community we have in mind, that is, whether we are talking about a small research centre or a larger group of scientists.

cognitive and non-cognitive goals, she may sometimes have some additional personal goals as well (e.g. advancement in her career, financial goals, ethical goals etc.). This may not only influence the way in which she puts the weighting on certain communal goals, but it may sometimes even lead to a conflict between her own goals and those of the community. For instance, the ethical goals of a scientist may conflict with the idea of vivisection, otherwise common for the community, which finds it conducive of certain epistemic goals. In this case, the scientist may challenge this approach of the community, in spite of being its member. As a result, her individual assessment of pursuit worthiness may have a different result from the communal one.

Similarly, in the case of epistemic pursuit worthiness, an individual scientist may place specific preferences on values that he considers to be epistemically relevant for his research goals. Hence, a theory that is epistemically individually worthy of pursuit for one scientist may not be so for another, while it is usually worthy of pursuit in the communal sense.

In this section we would like to point out two ways in which the individual and communal pursuit worthiness are used, which are especially significant for the scientific practice. More precisely, each of these two notions can be used to make a specific type of claim. On the one hand, individual pursuit worthiness can be given in the form of a *research directive*. On the other hand, communal pursuit worthiness can be given in the form of an *evaluative stance*. Let us take a closer look at each of these types of claims.

A claim of pursuit worthiness as a research directive gives an answer to the question: "Which theory should *Y* pursue?" or "Should *Y* pursue this theory?". The assessment of pursuit worthiness here takes into account the concrete research context of *Y*, and as a result, the set of goals (our variable *Z*) will usually include epistemic and non-epistemic goals. In other words, a claim of pursuit worthiness as a research directive usually falls under the practical pursuit worthiness. For instance, in case *Y*

is an individual scientist, we can speak of individual pursuit worthiness as a research directive. Note that in this type of assessment idiosyncratic factors may play a role too, as Kuhn already emphasized (Kuhn, 1977, p. 320-339).

However, if we take *Y* to be a scientific community in a broad sense, that is, as consisting of scientists in the given domain in general, communal pursuit worthiness may shift more towards the claim of an *evaluative stance*. Since *Y* is in this case usually not specified by any concrete practical context, the main concern of such an evaluation will be the question: "Would pursuing this theory be in the epistemic interest of science, that is, the respective scientific domain? ". Moreover, ideally, idiosyncratic values will not play a role in this type of evaluation. This can easily be clarified by means of an example of a rational reconstruction of a case from the history of geology. When Alfred Wegener proposed the theory of continental drift in 1910s-1920s, a number of earth scientists found this theory not only unacceptable, but not even worthy of pursuit (see (Šešelja and Weber, 2012)). Now, on the one hand, it could be asked whether Wegener and each of his followers had good reasons for pursuing the theory of drift. In this case, we may take a look at their arguments based on epistemic values, but also at their personal preferences, interests, and motivations. Hence, we are interested in the assessment of pursuit worthiness as a research directive. On the other hand, we may ask whether the epistemic reasons in terms of which Wegener and his followers argued that their theory was worthy of pursuit were epistemically warranted. In this latter case, we are interested in the communal pursuit worthiness as an evaluative stance. In other words, we are not interested in idiosyncratic reasons that motivated scientists to pursue the theory, but rather in the question, whether the theory was epistemically attractive for those domains of earth science for which this theory was relevant, and in this sense, for the geological community at the time.

One of the cognitive goals of the scientific community taken in this broad sense may be robustness of the scientific knowledge constituting the respective domain. In virtue of this goal, it is conducive for the scientific community to pursue a plurality of inquiries in order to assure (as much as that is possible) that the domain remains robust. Due to the necessary epistemic uncertainty regarding any (dominant) theory, the domain can remain robust by allowing for different back-up theories to be simultaneously developed (see (Šešelja and Straßer, 201x)).

A diversity of pursued paths within a scientific community is also of direct relevance for the value of pluralism in scientific theory and practice (e.g. (Kitcher, 1993, 2002); (Longino 2002), (Chang 2004, 2011); (Kellert and Longino 2006)). For this purpose, claims of communal pursuit worthiness as evaluative stances are especially important, since they allow scientists to assess inquiries as worthy of pursuit that are not directly related to their own research. Furthermore, this type of evaluation may often be done in terms of epistemic values alone, at least in cases in which ethical, social and other non-epistemic values are not a subject of a controversy. An important aspect of the communal pursuit worthiness as an evaluative stance is that a scientist working in one paradigm may evaluate a theory from another paradigm as worthy of pursuit without necessarily concluding that she herself should engage in its pursuit. For instance, this is important for scientific debates in which a scientist evaluates not only her own research path, but also those of other scientists, and engages in a rational discussion on their pursuit worthiness. She may not only be interested in the question what she is to pursue, but also, how cognitively or epistemically attractive other rivaling inquiries are. Moreover, by means of this type of assessment she may receive critical feedback from other scientists about her own research and its pursuit worthiness. Indeed, there is no a priori reason why a scientist

pursuing one theory would not be able to evaluate the communal pursuit worthiness of the rivaling theory.[15]

5.2 Communal pursuit worthiness and the value of pluralism

As we have mentioned above, the notion of communal epistemic pursuit worthiness in the form of an evaluative stance is especially important for the pluralism of pursued theories. It is also important for answering questions about the epistemic basis of a given pursuit, such as whether a pursuit of a certain theory is/was epistemically warranted, independently of the interests and motivations of individual scientists who actually pursue/d it. Even if no scientist pursues a given theory from some point on, we may still ask whether this theory has certain epistemic merits that make it sufficiently promising to be further investigated.[16]

Failing to recognize the distinctions between the individual and the communal pursuit worthiness in the sense indicated above can lead to certain ambiguities. For instance, when Nickles writes: "Deciding that a defective theory or model is worthy of further pursuit amounts to launching or continuing a research program" (Nickles, 2006, p. 168) – we can agree with this statement only if we understand it as a research directive. In case the claim of pursuit worthiness was given as an evaluative stance, it would not amount to launching or continuing the inquiry, since it entails no concrete practical commitments regarding it.

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[15] Even in view of Kuhnian incommensurability (see (Kuhn, 1962)), such an evaluative stance is possible by means of the process of persuasion, translation and interpretation explicated by Kuhn (see (Šešelja and Straßer, 201xa)).

[16] For an example of how this notion can be applied to a concrete case study, see (Šešelja and Weber, 2012).

An important consequence of the fact that more than one theory may at the community level be simultaneously evaluated as worthy of pursuit is that we do not necessarily need a dissent among scientists regarding the pursuit worthiness of theories in order to have a diversity in the context of pursuit. Scientists may agree that different theories are worthy of pursuit in the given domain and yet, each of them may engage in a pursuit of only one of them.

Surprisingly, this quite obvious point has been overseen by a number of authors who have discussed theory choice, especially with regard to scientific controversies. In order to have the diversity of theories that are actively pursued, they have often pointed out a disagreement among scientists as crucial for this purpose. We will take a look at two such examples.

Our first example is Thomas Kuhn's emphasis on dissent in scientific practice:

> Before the group accepts it, a new theory has been tested over time by the research of a number of men, some working within it, others within its traditional rival. Such a mode of development, however, *requires a decision process which permits rational men to disagree*, and such disagreement would be barred by the shared algorithm which philosophers generally have sought. If it were at hand, *all conforming scientists would make the same decision at the same time.* With standards of acceptance set too low, they would move from one attractive global viewpoint to another, never giving traditional theory an opportunity to supply equivalent attractions. With standards set higher, no one satisfying the criterion of rationality would be inclined to try out the new theory, to articulate it in ways which showed its fruitfulness or displayed its accuracy and scope. *I doubt that science*

> *would survive the change.* ((Kuhn, 1977, p. 332); italics added)

Kuhn here tells us that in view of the individual pursuit worthiness, different scientists may find different theories more worthy of pursuit than others, and hence, each of them may decide to engage in a pursuit of another one. Note that the idea of pursuit worthiness here appears as a research directive. In order to assure a diversity of pursued theories, Kuhn argues that we need to allow for a disagreement among scientists regarding their research paths.

What Kuhn here overlooks is the notion of communal pursuit worthiness as an evaluative stance. It is clear that the pursuit of different paths by scientists leads to scientific pluralism. However, what deserves some more discussion is the claim that this is essential to pluralism.[17] First of all, it is not clear where the disagreement really lies in case the subject matter concerns the individual pursuit worthiness of theories as a research directive. There is no disagreement between the conclusion of a scientist *A*: "I should pursue theory T_1" and the conclusion of a scientist *B*: "I should pursue theory T_2". Rather, a disagreement would only concern a more general claim regarding the pursuit worthiness of a theory that is not relativized to one's own research activity.

However, making a claim of communal pursuit worthiness as an evaluative stance does not require a "shared algorithm" which delivers as an output a unique theory that is worthy of pursuit. In contrary, both (some) new candidates as well as the traditional rival could simultaneously be assessed as worthy of pursuit. Scientists may still have

[17] Also, according to Paul Hoyningen-Huene's reading of Kuhn "This disagreement is vital for the distribution of risk in a situation of epistemic uncertainty as no one knows which candidate for paradigmatic theory will be successful." (Hoyningen-Huene, 2006, p. 128).

different preferences concerning the question which theories they find most worthy to work on. This way a discipline may be characterized by the plurality of pursued theories without any disagreement being necessary for it. Hence, Kuhn's dilemma from the previous quote can be avoided. Of course, there may still be a disagreement about the pursuit worthiness of some candidates. However, this disagreement seems not anymore essential to pluralism.[18]

Our second example is from (Rueger, 1996), which shows a similar neglect of this point. With regard to the pursuit of scientific theories, Alexander Rueger writes:

> […] suppose that we had a generally followed set of rules for rational pursuit. Then all rational scientists, or at least almost all, would make the same decision concerning the choice of a theory to work on. This would destroy an essential condition for progress within scientific community. […]
> If each member of the community would follow the rule for pursuit, there would just be one preferred theory for the whole group to work on. Rational behavior of this sort could not produce the diversity of research that seems important to scientific progress. (Rueger, 1996, p. 265)

What Rueger here neglects is that "a generally followed set of rules for rational pursuit" may be construed as the communal pursuit worthiness. In contrast, the decisions that scientists make concerning the choice of a theory to work on refers to claims of individual pursuit worthiness as a

[18] In (Šešelja and Straßer, 201xa) the above presented problem of pluralism in Kuhn's work is further explicated by pointing to Kuhn's epistemic semantic monism (see also (Chang, 2011)).

research directive. However, the communal pursuit worthiness (especially in the form of an evaluative stance) does not amount to an assessment which necessarily gives one unique preferred theory.

In view of these two examples[19] we can conclude that a neglect of a very simple thought – that more than one theory can be evaluated as worthy of pursuit at the same time – can lead to unfounded ideas regarding the rationality of scientific reasoning in the context of pursuit.

6. Conclusion

In this paper we have presented some of the crucial aspects of rationality underlying the context of theory pursuit. By proposing a unifying pattern of pursuit worthiness: "It is rational for *Y* to pursue *X* if and only if *X* is conducive of the set of goals *Z*.", we have indicated in which way different notions of pursuit and pursuit worthiness can be distinguished. First we have distinguished different units of appraisal in the context of pursuit (variable *X*), which allow for a more precise disambiguation of the idea of pursuit worthiness. In this regard, we have distinguished between the pursuit of scientific theories, epistemic objects and technological developments. Next, we have distinguished between the epistemic and the practical pursuit worthiness (with regard to variable *Z*), and between the communal and the individual pursuit worthiness (with regard to variable *Y*). We have shown that overlooking these distinctions can lead to unwarranted conclusions regarding the rationality of scientific reasoning in the context of pursuit.

[19] A similar point could also be made for Richard E. Grandy's argument for diversity of pursuit (see (Grandy, 2000)).

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REFERENCES

Beatty, J. & Moore, A.: 2010, Should we aim for consensus? Episteme 7, 198-21

Carrier, M.: 2010, Knowledge, politics, and commerce: Science under the pressure of practice, in M. Carrier and A. Nordsmann (eds), Science in the Context of Application. Methodological Change, Conceptual Transformation, Cultural Reorientation, Springer, Dordrecht.

Chang, H.: 2004, Inventing Temperature: Measurement and Scientific Progress. Oxford University Press.

Chang, H.: 2011, The persistence of epistemic objects through scientific change. Erkenntnis 75, 413–429.

Curd, M. V.: 1980, The logic of discovery: An analysis of three approaches, in nickles80, pp. 201–219.

Douglas, H. E.: 2009, Science, Policy, and the Value-Free Ideal, University of Pittsburgh Press.

Elliott, K. C. and McKaughan, D. J.: 2009, How values in scientific discovery and pursuit alter theory appraisal, Philosophy of Science 76, 598–611.

Gilbert, M.: 1987, Modelling collective belief, Synthese 73(1), 158-204.

Grandy, R. E.: 2000, On the cognitive analysis of scientific controversies, in M. P. Peter Machamer and A. Baltas (eds), Scientific Controversies: Philosophical and Historical Perspectives, Oxford University Press, New York, Oxford, pp. 67–77.

Hoyningen-Huene, P.: 2006, Context of discovery versus context of justification and Thomas Kuhn, in (Schickore and Steinle 2006), pp. 119–131.

Kellert, S. H., Longino, H. E. and Waters, C. K. (Eds.): 2006,. Scientific pluralism. University of Minnesota Press.

Kelly, T.: 2003, Epistemic rationality as instrumental rationality: A critique, Philosophy and Phenomenological Research 66(3), 612-640.

Kitcher, P.: 1993, The Advancement of Science: Science without Legend, Objectivity without Illusions. Oxford University Press.

Kitcher, P.: 2001, Science, Truth and Democracy, Oxford University Press, New York.

Kitcher, P. 2002, The third way: Reflections on Helen Longino's the fate of knowledge. Philosophy of Science 69, 549-559.

Kuhn, T.: 1977, The Essential Tension: selected studies in scientific tradition and change, University of Chicago press, Chicago.

Kukla, A.: 2001, Seti: On the prospects and pursuitworthiness of the search for extraterrestrial intelligence, Studies in History and Philosophy of Science Part A 32(1), 31–67.

Lacey, H.: 2004, Is there a significant distinction between cognitive and social values? in P. Machamer and G. Wolters (eds), Science, Values and Objectivity, Pittsburg University Press, Pittsburg, pp. 24-51.

Lacey, H.: 2005, On the interplay of the cognitive and the social in scientific practices, Philosophy of Science 72(5), 977–988.

Lacey, H: 2009, The Interplay of Scientific Activity, Worldviews and Value Outlooks, Science & Education 18, 839–860.

Lakatos, I.: 1978, The methodology of scientific research programmes, Cambridge University Press, Cambridge.

Laudan, L.: 1977, Progress and its Problems: Towards a Theory of Scientific Growth, Routledge & Kegan Paul Ltd, London.

Laudan, L.: 1980, Why was the logic of discovery abandoned? , in (Nickles 1980), pp. 173–184.

Laudan, L.: 2004, The epistemic, the cognitive, and the social, in P. Machamer and G. Wolters (eds), Science, Values, and Objectivity, University of Pittsburgh Press / Universitätsverlag Konstanz.

Longino, H.E.: 2002, The fate of knowledge, Princeton University Press, Princeton.

McKaughan, D. J.: 2008, From ugly duckling to swan: C. S. Peirce, abduction, and the pursuit of scientific theories, Transactions of Charles S. Peirce Society 44(3), 446-468.

McMullin, E.: 1976, The fertility of theory and the unit for appraisal in science, in R. S. Cohen, P. K. Feyerabend and M. W. Wartofsky (eds), Essays in Memory of Imre Lakatos, Vol. 39 of Boston Studies in the Philosophy of Science, D. Reidel Publishing Company, Dordrecht, pp. 395–432.

Nickles, T.: 2006, Heuristic appraisal: Context of discovery or justification? , in (Schickore and Steinle 2006), pp. 159–182.

Nickles, T. (ed.): 1980, Scientific Discovery: Case Studies, D. Reidel Publishing Company., Dordrecht.

Reichenbach, H.: 1938, Experience and Prediction. An Analysis of the Foundations and the Structure of Knowledge, University of Chicago Press.

Rheinberger, H.-J.: 1997, Toward a history of epistemic things: Synthesizing proteins in the test tube, Stanford University Press.

Rueger, A.: 1996, Risk and diversification in theory choice, Synthese 109(2), 263–280.

Schickore, J. and Steinle, F. (eds): 2006, Revisiting Discovery and Justification: Historical and philosophical perspectives on the context distinction, Springer, Netherlands.

Šešelja, D. and Straßer, C.: 201x, Epistemic justification in the context of pursuit: A coherentist approach, Synthese, accepted for publication.

Šešelja D. and Straßer C.: 201xa, Kuhn and the question of pursuit worthiness, submitted to *Topoi*.

Šešelja, D. and Weber, E.: 2012, Rationality and Irrationality in the History of Continental Drift: Was the Hypothesis of Continental Drift Worthy of Pursuit? , Studies in History and Philosophy of Science, Part A, Vol. 43, pp. 147-159.

Solomon, M.: 2006, Groupthink versus the wisdom of crowds: The social epistemology of deliberation and dissent, Southern Journal of Philosophy 44, 28-42.

Spohn, W.: 2002, The Many Facets of the Theory of Rationality. Croatian Journal of Philosophy 2 (3):249-264.

Tursman, R.: 1987, Peirce's theory of scientific discovery, Indiana University Press. Bloomington and Indianapolis.

Van Fraassen, B. C.: 1989, Laws and symmetry, Oxford University Press, Oxford.

Whitt, L. A.: 1990, Theory pursuit: Between discovery and acceptance, PSA: Proceedings of the Biennial Meeting of the Philosophy of Science Association, Vol. 1, pp. 467–483.

Whitt, L. A.: 1992, Indices of theory promise, Philosophy of Science 59, 612–634.