

What should a normative theory of values in science accomplish?

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Introduction

In 1992 PSA meeting Phyllis Rooney put forward the question of whether the distinction among epistemic and non-epistemic values is useful in philosophy of science and especially in feminist philosophy of science. This question arises against a background where a number of philosophers and historians of science have come to embrace the view that scientific judgement is with some respects and to some degree closer to value judgement than to rule-governed inference.¹ The claim that scientific judgement is akin to value judgement is often accompanied by the normative claim that scientific judgement should be guided by the so called epistemic values (McMullin 1983) or cognitive values (Laudan 1984) or constitutive values (Longino 1990). The conception of theory appraisal as value judgement has also lead many philosophers of science to recognize that a normative theory of

¹By scientific judgement I mean the decision to accept a hypothesis or a theory. To accept a hypothesis means that one believes that a hypothesis is well supported by relevant empirical evidence. To accept a theory means that one believes that a theory is the best available theory about the subject matter of inquiry. To say that the standards of scientific judgement function as values rather than as rules means that those standards do not function as necessary conditions of the acceptability of a theory or as sufficient conditions of the acceptability of a theory (or as necessary and sufficient conditions of the acceptability of a theory). Instead, they function as ideals that scientists should try to realize to a higher and higher degree, and as ideals they can be applied in scientific judgement in a flexible manner.

scientific judgement does not need to provide an algorithm of theory choice. Whereas rule-governed inference was ideally thought to determine scientific judgement, values, it is often argued, influence scientific judgement but do not determine it uniquely (Kuhn 1977). This is because different scientists may interpret and apply the same values in different ways, and thus come up with different assessment of the acceptability of a theory. Scientists may also assign the same values a different order of priority. Moreover, if it is possible to interpret, apply, and weigh epistemic (or cognitive or constitutive) values differently, then it is also possible that other values than epistemic (or cognitive or constitutive) values enter into the assessment of theories. This has lead philosophers to debate whether other than epistemic (or cognitive or constitutive) values are allowed to play a role in methodologically sound scientific judgement, and if they are, what their role might be (Anderson 1995, Haack 1996, Longino 1990 and 1996, Nelson 1996, Nelson and Nelson 1995, Potter 1995, Rooney 1992, Wylie 1995).

The above summary is merely an outline of the recent debate about the nature and the role of values in science. To be able to answer the question of whether the distinction among epistemic and non-epistemic values is useful in philosophy of science and especially in feminist philosophy of science, we need to examine how these concepts are defined and how they function in normative statements about scientific judgement. This is the task I undertake in this presentation. My aim is to argue for a view about what such conceptual distinctions should be able to accomplish in a normative theory of scientific judgement. I have decided to focus on two pieces, Ernan McMullin's essay "Values in

science" (1983) and Helen Longino's *Science as social knowledge* (1990), because I think that the essential disagreements in this debate can be articulated and analyzed by examining these works.

Let me begin with a preliminary comparison of McMullin's and Longino's views to clarify what issues are at stake in the debate about values in science. For McMullin (1983) epistemic values are primarily desirable features of theories or research programs (15). As examples of epistemic values he mentions predictive accuracy, internal coherence, external consistency, unifying power, fertility, and simplicity. Epistemic values may also be desirable features of empirical data, such as the reproducibility of data in an experiment and accuracy in measurement (18). McMullin defines the criterion for an epistemic value in the following way: A value is epistemic in a particular context if and only if there are sufficient reasons for holding that it promotes or helps to achieve the truth-like character of science in that context.² According to this definition, truth is neither an epistemic nor a non-epistemic value. Truth is the goal of science which defines the epistemic/non-epistemic distinction. In McMullin's terminology, truth is a transcendental or constitutive value of science (7). McMullin introduces the epistemic/non-epistemic distinction for the purpose of making normative claims about scientific judgement. He claims that epistemic values ought to guide

² I have extracted this definition from the following two passages in McMullin's essay: "An epistemic value is one we have reason to believe will, if pursued, help toward the attainment of such [truth-like] knowledge." (18) "When no sufficient case can be made for saying that the imposition of a particular value on the process of theory choice is likely to improve the epistemic status of the theory, that is, the conformity between theory and world, this value is held to be non-epistemic in the context in question." (19)

theory appraisal, whereas non-epistemic values will be and ought to be eliminated from theory appraisal in the long run (23).³

Helen Longino (1990) has introduced a distinction among constitutive and contextual values. By constitutive values she means the values that are generated from an understanding of the goals of science (4). Constitutive values may, for instance, be features that characterize a good explanation (such as truth, accuracy, simplicity, predictability, and breadth). But they may also be properties of other things than the knowledge-products of science (such as data, hypotheses, theories, and research programs). In Longino's view constitutive values may be desirable properties of scientific communities or the processes whereby knowledge is produced.⁴ By contextual values Longino means values that belong to the social and cultural environment where science is done (4). Notice that whereas McMullin's distinction among epistemic and non-epistemic values is defined so that epistemic and non-epistemic values form two mutually exclusive categories of values, at least on the face of it Longino's

³ Notice that in McMullin's view non-epistemic values may play a role in pragmatic decisions such as a decision to end an experiment or a decision to approve a theory as a basis of action, but non-epistemic values are not allowed to play a role in the properly speaking epistemic decisions such as a decision to believe a theory or a part of a theory to be true (8). This claim relies on the assumption that within the practice of science we can distinguish among pragmatic and epistemic decisions. Yet McMullin admits that it is often hard to draw the line among pragmatic and epistemic decisions (18).

⁴ Longino claims that in order to achieve a high degree of objectivity, a scientific community should strive to realize the following four requirements: (1) There must be recognized avenues for criticism, (2) there must exist shared standards, (3) the community as a whole must be responsive to criticism, and (4) intellectual authority must be equally shared among qualified practitioners (76).

distinction among constitutive and contextual values does not carry such an implication. We would have to attend closely the way she uses these concepts to find out whether she intends them to form two mutually exclusive categories of values.

There are other interesting differences among the distinctions introduced by McMullin (1983) and Longino (1990). Both McMullin and Longino define epistemic or constitutive values as the values that are justified or justifiable with respect to the goals of science.⁵ But whereas McMullin endorses truth as the goal of science, Longino does not commit herself to any definite view about the goals of science (19). Whereas McMullin claims that non-epistemic values will be and should be eliminated from scientific judgement in the long run, Longino does not claim that the presence of contextual values in scientific judgement will necessarily lead to methodologically illegitimate science (128). She argues that the ideal of value-freedom (understood as freedom from contextual values) places unrealistic constraints on science as we know it (13). For instance, in some cases contextually value-laden background assumptions may be the only means available to establish the relevancy of data for a hypothesis.⁶

⁵There are also other views about how values in science are to be justified. Larry Laudan (1984) has argued that cognitive values can be justified with respect to theories and methods of science as well as the aims of science.

⁶Notice also that McMullin advocates scientific realism and Longino advocates empiricism. So, when Longino claims that contextual values may influence methodologically sound scientific judgement, she does not thereby imply that contextual values may be called in to justify a leap of faith from empirical data to a theory. This is because as an empiricist she holds that at most we can know whether the empirical parts of theories are true; as to the other parts, we cannot know. Therefore, to say that contextual values are allowed to play a role in

Therefore, it is not evident that Longino's distinction among constitutive and contextual values embodies or is even meant to embody the same conceptual structures as McMullin's distinction among epistemic and non-epistemic values.

Moreover, both Longino's and McMullin's concepts are in need of further clarification. At one instance Longino (1990) claims that constitutive values are the values that characterize acceptable scientific practice or scientific method (4). Yet her case study of gender dimorphism in neuroendocrinology suggests that not all values that function as constitutive values in science are the kind of values feminists want to accept. In the research program on the hormonal basis of human behavior, the goal of inquiry is to explain alleged sex differences in human behavior in terms of hormonal functioning. This goal defines what kind of evidence is understood to be relevant and how constitutive values such as simplicity are interpreted and applied. Relevant evidence is, for instance, the kind of evidence that describes human behavior as either conforming or failing to conform to what is considered to be gender appropriate behavior. A simple explanation is, for instance, the kind of explanation that is able to establish linear causal connections among hormonal functioning, inherent capacities and dispositions, and manifest behavior. Longino argues that the goals of this research program are motivated and justified by contextually value-laden assumptions, such as the assumption that there are two types of gender appropriate behavior and these two types are complementary of each other. These assumptions are

theory choice does not imply that contextual values may justify a belief in a theory's being true.

if not sexist at least heterosexist. Therefore, feminists should not uncritically accept the aims of this research program and the values generated from these aims. To say the least, the acceptance of these aims and values would require a critical discussion about their social and political motivations and consequences.

In light of this example, it seems to me that Longino would want to say that contextual values may function as constitutive values in science without thereby implying that these values are acceptable or legitimate. Yet her characterization of constitutive values as necessarily acceptable or legitimate values (i.e. acceptable or legitimate in virtue of their definition) would make this statement conceptually impossible. It seems to me that her use of the term constitutive is not fully consistent. More work obviously needs to be done to sort out these conceptual problems.

McMullin's use of the term of epistemic is not fully consistent either. At one point he says that non-epistemic values should not be allowed to influence scientific judgement in the long run (1983, 23). At another point he admits that metaphysical beliefs (such as Newton's theological views) are non-epistemic factors that may function like epistemic values in scientific judgement (19). But if some non-epistemic factors are allowed to function like epistemic values in scientific judgement, then they are legitimate considerations in grounding scientific judgement (which contradicts his own statement). Moreover, if Longino is right in claiming that contextual values may be encoded in how constitutive values are understood, why should we believe McMullin's claim that if scientists persistently apply epistemic values in theory appraisal, then non-epistemic values will

be eliminated from scientific judgement in the long run?⁷

For the above mentioned reasons I agree with Phyllis Rooney that there is little clarity or agreement about the nature and the function of distinctions among different types of value in science.⁸ Her diagnosis of the problem is that "We haven't seen anything resembling a clear demarcation of epistemic values because there is none to be had." (1992, 15) She concludes that we should not seek to regroup values as epistemic and non-epistemic but adopt a different attitude towards the distinction (21). She suggests that we locate values in science on a continuum scale rather than group them into two distinct categories.

I do not agree with Phyllis Rooney's conclusion. I think that the case study of gender dimorphism in neuroendocrinology and many other

⁷It is not immediately evident that McMullin's category of non-epistemic values overlaps with Longino's category of contextual values, but at least the heterosexist assumptions Longino analyzes in her case study would be non-epistemic in the sense McMullin uses the term.

⁸Demands for explication is also evoked by the characterization of contextual values as personal, social, and cultural values (Longino 1990, 4) and non-epistemic as political, moral, social, and religious values (McMullin 1983, 19). These characterizations are problematic since, for instance, the goals of science may be personal for a scientist who identifies with them; the goals of science may be social in the sense that they are collectively accepted by a scientific community; and the goals of science may even be cultural in the sense that they reflect one culture of cognitive practices rather than another (as for instance Andrew Pickering (1984) has argued in his sociological study of scientific change in high energy physics). Perhaps Longino and McMullin do not have this kind of personal, social, and cultural values in mind when they say that contextual or non-epistemic values are personal, social, or cultural values. Yet these comments point towards a need to specify what kind of personal, social, and cultural values are properly speaking contextual or non-epistemic. However, this is not the main focus of this presentation.

case studies done by feminist scholars provide a reason to develop conceptual distinctions among different types of value in science.⁹ The purpose of these distinctions should be to enable philosophers to distinguish legitimate goals and values from the goals and values that lack sufficient legitimation (even if some scientists think that those goals and values are legitimate in their field of inquiry). It may not be reasonable to require that all contextual influence is eliminated from methodologically sound scientific judgement since this requirement would leave us with too narrow a conception of what counts as methodologically sound science (Anderson 1995, Longino 1990 and 1996, Nelson 1990 and 1996, Potter 1995).¹⁰ But we can hope to be able to distinguish legitimate contextual influence from illegitimate contextual influence. Within the scope of this presentation it is not possible to develop a complete account of how this might be done. But I hope to be able to argue for a view about what such an account should accomplish.

My argument will proceed in three steps: I will argue first that McMullin's epistemic/non-epistemic distinction is based on a problematic understanding of the goals of science. Second, I will argue that Longino offers a more adequate understanding of the goals of science but her concept of constitutive value is not sufficiently

⁹E.g. The Gender and Biology Study Group 1989, Potter 1993, and Keller 1995.

¹⁰Nelson (1995) and Potter (1995) have argued that the question of whether contextual values have influenced methodologically sound scientific judgement is properly understood as an empirical question. To assume at the outset that scientific judgement influenced by contextual values is "bad" science would be question-begging.

normative. Third, I will conclude that a normative theory of values in science should address the normative concerns central to McMullin's essay while integrating the more complex understanding of the goals of science emerging from Longino's work. So, as a response to Phyllis Rooney's question "Is the epistemic/non-epistemic distinction useful?" I would say "Yes" - but with the added qualification that the epistemic/non-epistemic distinction will have to be revised for it to be able to do the kind of normative work we want it to do.

Epistemic and non-epistemic values

Recall that according to Ernan McMullin's (1983) definition, a value is epistemic in a particular context if and only if there are sufficient reasons for holding that it promotes or helps to achieve the truth-like character of science in that context. As this definition indicates, McMullin does not think that epistemic values are self-justificatory. Epistemic values are the values that are justified or justifiable with respect to what McMullin thinks is the goal of science: truth. Therefore, it does not follow from McMullin's definition that whatever some scientists or philosophers endorse or treat as an epistemic value really is an epistemic value; we can ask whether the adoption of a particular value actually promotes truth in some context. Another thing to notice in McMullin's definition is that the status of a value with respect to the epistemic/non-epistemic distinction is context-dependent. If we accept McMullin's definition, then it is possible, at least conceptually, that a value is epistemic in one context and non-epistemic in another context of inquiry.

Besides a definition, McMullin (1983) also provides a list of values which he thinks are epistemic in the sense of being truth-conducive. The following values are included in his list: (1) predictive accuracy (which means that predictions agree with empirical evidence); (2) internal coherence (which means that theories should not contain logical inconsistencies, unexplained coincidences, or ad hoc explanations); (3) external consistency (which means consistency with other accepted theories and with the general background of expectation); (4) unifying power (which means the ability of a theory to bring together hitherto disparate areas of inquiry); (5) fertility (which means the capacity of a theory to generate novel predictions that were not part of the set of original explananda); and finally (6) simplicity (the meaning of which is not clear, McMullin points out).¹¹

McMullin (1983) also points out that his list of epistemic values is tentative and non-exhaustive. He argues that a tentative list is the best we can hope for since a judgement about whether a value is truth-conducive in some particular context has to be based on experience. We cannot definitively establish the status of a value as epistemic since future experience may always prove things otherwise (18). To be able to decide whether a value is epistemic we need to know the consequences the adoption of that value has in a particular historical, social, and cultural context. We cannot assume on a priori grounds alone that the consequences are going to be the same in all contexts. Yet it is interesting to notice that even though McMullin

¹¹McMullin's list of epistemic values is a modification of Thomas Kuhn's (1977) list which includes accuracy, internal and external consistency, broad scope, simplicity, and fruitfulness.

emphasizes the context-dependent and contingent nature of epistemic values, he argues that the values on his list are epistemic independently of the context or in almost any context. As evidence for this sweeping thesis, he claims that these values have been tested in the history of science. As McMullin himself puts it: "The characteristic values guiding theory-choice are firmly rooted in the complex learning experience which is the history of science; this is their primary justification, and it is an adequate one." (21)

Before I will proceed to discuss the problematic aspects in McMullin's concept of epistemic value, I want to point out some of its virtues. One virtue is the very idea that the purpose of a conceptual distinction among different types of value in science is to distinguish the values that are allowed to or should be applied in grounding scientific judgement from the values that are not allowed to be used as a basis of scientific judgement. As I have already indicated, feminist criticism of science provides a reason to develop a conceptual framework that enables philosophers to entertain the possibility that not all values that scientists think are acceptable really are acceptable. However, we still need to consider the question of whether McMullin's epistemic/non-epistemic distinction is up to this task.

Another virtue in McMullin's definition is the view that experience is the main arbiter in a judgement about whether a value is epistemic in some particular context. This view makes it possible for feminist philosophers of science to hold that social, moral, or political values in science are not good or bad in and by themselves; whether they promote a better understanding of some aspects of the

world or function as a source of distortion or bias (or in some other way) is to be judged on the basis of historical experience. The view that experience is the main arbiter in a judgement about whether a value is epistemic also enables feminists philosophers of science to argue that the values embraced by some feminists scientists (such as the applicability of knowledge to human needs, ontological heterogeneity, and complexity of interaction) are on an equal standing with such values as fertility and simplicity (Longino 1994, 1995, and 1996).

Phyllis Rooney (1992) points out that McMullin's definition of epistemic value relies on a contested view about the goal of science. There is no wide agreement about truth being the goal of science.¹² Nor is there wide agreement about how truth as the goal of science is to be understood. Some philosophers of science have argued that truthlikeness is a more likely candidate for the goal of science than truth (Niiniluoto 1987). Sometimes truth is understood as a desirable property of theories, sometimes it is understood as a desirable property of the empirical parts of theories only (van Fraassen 1980). How truth or truthlikeness is understood depends also on whether scientific theories are thought to consist of statements or models (Giere 1988). Yet other philosophers have argued that the goal of science is truth with some added qualifications. Since there are true statements that are non-informative or trivial and uninteresting, we have to specify what truths are the goal of scientific inquiry. The

¹²For example, Larry Laudan (1984) has argued that truth cannot be the goal of science, because we do not know when we have achieved a true theory (Laudan 1984). This is why Laudan prefers the term cognitive value in place of McMullin's epistemic value.

goal of inquiry should be taken to be the production of not merely true statements but true statements that are significant for our understanding of the world (Kitcher 1992). Yet another reason to require that we specify what truths are the goal of scientific inquiry is that some true statements may give us merely a partial or a biased picture of the subject matter. Hence, the goal of science should be taken to be the production of a true and complete (or non-biased) account of the subject matter of inquiry (Anderson 1995). Besides truth and truthlikeness, other often endorsed candidates for the goal of science are effectivity in problem-solving, instrumental success, understanding, explanation and prediction.

I think that Rooney is right in pointing out that McMullin's view of truth as the goal of science is contested. Yet I think that there is a deeper problem buried in McMullin's definition of epistemic value. Notice that when McMullin says that the goal of science is truth, he makes a normative statement of the form: the goal of a practice has to be truth if that practice is to count as science. We could say that for McMullin truth is a necessary goal of science. Thus, McMullin defines epistemic values with respect to what he thinks is a necessary goal of science. But if the purpose of the concept of epistemic value is to enable us to distinguish legitimate values from those values that lack legitimation (as McMullin obviously intends his distinction to function), then why should we define legitimate values on the basis of whether they promote the necessary goals of science? Why not define legitimate values so that they are the values that promote or help to achieve the legitimate goals of science?

This question arises because we can make a distinction among the

necessary goals of scientific inquiry and those goals that are not necessary to scientific inquiry but nevertheless are allowed to guide it. For instance, different disciplines, subdisciplines, and research programs are characterized by field-specific goals that are not shared by other disciplines, subdisciplines, and research programs. Another reason why we can distinguish necessary goals and legitimate but not necessary goals in science is that there have been historical episodes in science where some goals have been relinquished and others adopted (Kuhn 1970). Yet we do not always say that the practice has thereby ceased to be scientific. For these reasons we should not adopt a conceptual framework that assumes at the outset that all legitimate goals of scientific inquiry are also necessary goals of science or even a field of science.

As I have already pointed out in the introduction, McMullin makes the problematic assumption that if scientists persistently apply epistemic values in scientific judgement, then non-epistemic values will be eliminated from science in the long run. This assumption is problematic because non-epistemic values may be encoded in how epistemic values are interpreted and applied in grounding scientific judgement. As Longino (1990) has argued, this has actually been the case in the research program on the hormonal basis of alleged sex differences in human behavior. In this section I have shown that at the root of McMullin's problematic assumption is his equally problematic conception of the goal of science. Because by the goal of science McMullin understands the necessary goal of science, he has not conceived of the possibility that non-epistemic values influence the goals of science. And because he defines epistemic values merely with

respect to the necessary goal of science, he has not conceived of the possibility that non-epistemic values are encoded in how epistemic values are interpreted and applied in grounding scientific judgement. For a more adequate understanding of the goals of science, I turn next to Helen Longino's *Science as Social Knowledge*.

Constitutive and contextual values

Recall that by constitutive values Helen Longino (1990) means the values that are generated from an understanding of the goals of science (4). Unlike McMullin Longino does not commit herself to a definite conception about what the goals of science are (19). She says that there are two widely acknowledged conceptions of the goals of science. According to one conception, the primary goal of science is the construction of comprehensive accounts of the natural world (32). According to the other conception, the primary goal of science is the discovery of truth about the natural world (33). Longino seems to think that neither one of these two conceptions is satisfactory because it does not provide a sufficiently accurate description of the actual goals of any scientific practice (99). If we want our philosophical theories of science to be empirically adequate accounts of scientific practice, then an accurate description of the goals of scientific inquiry is a desideratum for our theories.

Longino (1990) holds that the goals of scientific inquiry are more adequately understood as complex descriptions of the kind of understanding or explanation a field of inquiry or a research programs aims to provide (99). This complex description may, for instance,

include a preliminary description of the object or the subject matter of inquiry (99). As Longino puts it, the object of inquiry is never just nature or some discrete part of the natural world but nature under some description (99). According to Longino, truth is a necessary component in the complex description of a goal in science but truth alone is not sufficient to make the description complete. As she puts it: "The sciences seek not simply truths but particular sorts of truths." (101)

At first glance it may seem that Longino uses the term constitutive in the same sense as McMullin uses the term epistemic (that is, epistemic values are the values justified or justifiable with respect to the goal of science, truth). However, this is not the case. Whereas McMullin defines epistemic values with respect to what he thinks is the necessary goal of science (truth), Longino defines constitutive values with respect to the actual and historical goals of science, that is, the goals that actually direct contemporary science or have directed science in the past. This view I think is implicit in Longino's claim that constitutive values are generated from the goals of science and the goals of science are adequately understood as complex descriptions of the kind of understanding or explanation scientists seek or have sought in the past. Notice that these two different definitions have different implications. If we agree with McMullin that science is a truth-seeking practice, then saying that a value is epistemic implies that that value may be legitimately used in grounding scientific judgement. In other words, if we adopt McMullin's view, a value is legitimate in virtue of being epistemic. However, in saying that a value is constitutive (in the sense Longino uses the

term), we are saying that a value is successful in taking scientists towards the goals of their inquiry, but we are not saying anything about whether the goals of their inquiry are acceptable or legitimate. If we require that legitimate values are generated from legitimate goals, then to say that a value is constitutive (in the sense Longino uses the term) is not yet to say anything about whether the value really is an acceptable or legitimate basis of scientific judgement. In other words, to say that a value is constitutive does not imply that it is legitimate.¹³

As I have already indicated in the introduction, I think that Longino's case study on neuroendocrinology provides a reason to develop the kind of concepts that enable philosophers to distinguish legitimate goals and values in science from the goals and values that lack sufficient legitimation (even if some scientists think that those goals and values are legitimate in their field of inquiry). The point in telling the story about the research program on the hormonal basis of alleged sex differences in human behavior is that we should not uncritically accept the goals and values that scientists accept. However, as Longino uses the term constitutive, it does not demarcate legitimate values from values that lack legitimation (and perhaps it is not even meant to do so). To say that a value is constitutive is merely to evaluate its instrumental success in taking scientists towards the goals of their inquiry. Instrumental success may be a

¹³Obviously, Longino's distinction among constitutive and contextual values does not coincide with McMullin's distinction among epistemic and non-epistemic values in science. Constitutive values are not always or necessarily legitimate values (as epistemic values are for McMullin). And contextual values are not always or necessarily illegitimate values (as non-epistemic values are for McMullin).

partial requirement for a value being a legitimate basis of scientific judgement but I think that it is not a sufficient requirement. To explain why let me review Longino's arguments for the claim that contextual values may be embedded in the very goals of scientific inquiry.

Recall that by contextual values Longino (1990) means the values that belong to the cultural and social environment in which science is done (4). Notice that this characterization does not preclude the possibility that some values are both constitutive (in the sense that they are justified or justifiable with respect to the actual or historical goals of scientific inquiry) and contextual (in the sense that they give an expression to or are motivated by values belonging to the social and cultural environment of science). This is possible because the complex description of the actual or historical goals of scientific inquiry may include contextual elements. As Longino puts it, the preliminary description of the object of inquiry is a function of the kind of knowledge scientists seek about the object, and hence, "a matter of *decision, choice, and values as much of discovery*" (100).

Longino cites two episodes in the history of science where the goals of inquiry have been justified or motivated by contextual values and interests. She points out that in early modern physical sciences an originally contextual interest in the manipulation of natural processes under controlled circumstances became to function as the main goal of inquiry in physical sciences (perhaps with the exception of astronomy). This meant that the manipulation of natural processes under controlled circumstances was not merely a practical goal that determined how scientific knowledge was to be applied; the

manipulation of natural processes under controlled circumstances functioned as the main goal of inquiry in the sense that it defined what it meant to understand nature and explain natural phenomena. For instance, a mechanical explanation was considered more appropriate for understanding nature than a teleological explanation. This example is not, of course, original to Longino; what interests me here is how she uses the term "contextual" to interpret historical studies on early modern physical sciences. To say that a value is contextual should not always be taken to mean that it is external to science. Contextual values may be expressed in or motivate or legitimate the goals of inquiry. The other and the more original example provided by Longino has already been introduced. In the research program on hormonal functioning and human behavior, the goal is to explain what is believed to be gender inappropriate behavior in terms of abnormal hormonal functioning. According to Longino, this goal is motivated and justified by the contextually value-laden assumptions that there are two types of gender appropriate behaviors and these two types are complementary of each other.

In both of these two cases, contextual values and interests have defined what kind of understanding or explanation is sought in a scientific field or a research program. As Longino (1990) herself puts it, contextual values may be transformed into constitutive values (100). I think that these case studies point towards a solution to the problem of defining the values that can be a legitimate basis of scientific judgement. In addition to evaluating the instrumental success of a value in taking scientists towards the goals of their inquiry, we need to evaluate the goals of inquiry.

Conclusion: What does a normative theory of values in science need to accomplish?

I conclude that a normative theory of values in science should try to articulate a distinction among the values that can legitimately ground scientific judgement and the values that should not be allowed to do so. The reason for this is that sometimes philosophers of science may want to argue that some goals of inquiry that scientists consider legitimate are not really legitimate, or that some constitutive values of inquiry that scientists consider legitimate are not really legitimate. In order to be able to construct such arguments, philosophers need a conceptual framework that makes these statements conceptually possible.

As we have seen above, developing a distinction among legitimate and illegitimate values in science is the central concern in Ernan McMullin's essay. However, McMullin's epistemic/non-epistemic distinction is not up to this normative task because it relies on the problematic assumption that legitimate value in science are to be defined with respect to what he thinks is the necessary goal of science (truth). This assumption is problematic since the actual and historical goals of science are likely to be more complex than the necessary goals of science. The description of an actual or historical goal of scientific inquiry may include elements that legitimately guide scientific inquiry even though they are not necessary to it. Therefore, if we define legitimate values with respect to the goals of scientific inquiry, we should adopt the more complex understanding of

the goals of inquiry provided by Longino.

If we adopt a more complex understanding of the goals of inquiry, then the evaluation of values is also going to be a more complex affair. There are at least three different levels in the evaluation of values. First, we may ask whether a value is effective in taking scientists towards the goals of their inquiry in some particular context. To ask this question would be to ask whether a value is constitutive in the sense Longino has used that term. Second, we may ask whether the goals of scientific inquiry are legitimate in some particular context. This question would address the normative concern central to McMullin's essay. Obviously, the complex description of an actual or a historical goal of inquiry has to fulfil some minimum requirements in order for that goal to be a goal of scientific inquiry and not some other practice. But we should also keep in mind that a complex description of a goal of scientific inquiry is likely to include other components than the component necessary for any science, and we can and we should evaluate also these other components. We may ask for instance, whether the goals of scientific inquiry are interesting or important in some particular historical and social context. This would be a third and a perfectly legitimate level of evaluating values in science.

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