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Legal Questions and Scientific Answers : Ontological Differences and Epistemic Gaps in the Assessment of Causal Relations

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For Tobias, Idun and Hannes

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Contents

1 Introduction

1.1 Legal Questions and Scientific Answers

To be effective, laws must be applied to the world. This application gives rise to questions about what the world is like and whether the conditions required for legally relevant consequences to ensue prevail. Science is often called upon to assist in answering these questions.[1] *Prima facie*, the structure, and the division of labour involved in the use, of scientific knowledge in a legal context looks rather clear. Yet this interdisciplinary meeting gives rise to many problems and is a notorious source of frustration for lawyers and scientists alike. The purpose of this monograph is to draw attention to some of these problems, and to discuss the implications that they have and should have on the legal system.

On closer inspection, it soon becomes obvious that the use of scientific knowledge in a legal context is problematic. To begin with, science is not the objective provider of definitive answers that non-scientists sometimes believe it is. Scientific theories are known to be underdetermined by data; in principle an infinite number of theories will be compatible with the same limited set of data,[2] so something more than data is needed to determine which theory should be embraced. As is often pointed out, value judgements are made in

[1] "Science" will refer in this monograph to natural science, but much of what is said here applies to other kinds of science, too.

[2] See Duhem, *The Aim and Structure of Physical Theory*, 1991 (1906), pp. 180 ff. and Quine, "Two Dogmas of Empiricism", 1951, pp. 39 ff.

science, too, and these certainly may be relevant to this choice. Some values in science, such as the value of reliable knowledge, can be expected to be generally acknowledged; these largely define scientific research and influence its methods. Others, such as cultural values or the personal values of an individual scientist and his or her financiers, are subject to much greater variation.[3]

The underdetermination of scientific theories, and the consequent importance of values in scientific inference, becomes a potential problem when law and science meet. Where different scientists reach different conclusions – which, in a legal context, they often tend to do – it is reasonable to suspect that at least some of these conclusions have been influenced by factors that are irrelevant from a legal point of view. In order to make appropriate use of the scientific evidence, legal-decision-makers must therefore be able to assess the meaning and quality of the scientific evidence in a particular case. However, because, in the nature of things, many legal decision-makers lack scientific training,[4] there is a significant risk that the scientific information will be misunderstood or misapplied when it is used in a legal context. As is only to be expected, harsh criticism is often levelled at the legal usage of scientific knowledge.[5] In particular, the courts have been criticized for misunderstanding, or not making appropriate use of, statistical

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[3] It is generally acknowledged that values play a part in science; it has been debated which values do so, and in what way. See the debate in Rudner "The Scientist Qua Scientist Makes Value Judgments", 1953, Jeffrey, "Valuation and Acceptance of Scientific Hypotheses", 1956, Churchman, "Science and Decision Making", 1956, and Levi, "On the Seriousness of Mistakes", 1962. For a more recent and practical illustration of some of the issues at stake here, see Lackey, "Science, Scientists and Policy Advocacy", 2007, and Noss, "Values are a Good Thing in Conservation Biology". 2007. See also note 18 below.

[4] This is particularly true in Sweden, where an exam from law school normally includes four and a half years involving the study of law alone.

[5] Angell, *Science on Trial*, 1996, and Huber, *Galileo's Revenge*, 1991, are two examples of comprehensive and critical surveys of cases of alleged legal misuse of scientific evidence.

evidence.[6] And in addition to these problems, legal notions of, for instance, probability[7] and causation[8] are sometimes said to differ from their scientific counterparts. Certainly, such differences can cause trouble when science is used in a legal context.

In this monograph I am interested in problems that arise in the interstice between law and science, and in particular in those that are due to *legally relevant limits* of scientific knowledge. More precisely, I am interested in the ways in which the limits of scientific information limit our ability to answer legal questions. Because an inability to answer legal questions diminishes the effectiveness of the rules that give rise to those questions, these limits and their effects should be taken into proper account already at the level of legislation. The investigation will primarily be concerned with the possibility of answering questions about causation that arise in the application of rules which serve to counteract detrimental effects on human health and the environment in tort and environmental law.

In order to appropriately assess the legally relevant limits of scientific knowledge, it must first be recognized that law and science indeed are quite different projects, with different aims and functions. As a result of these differences, law and science ask different questions about the world. It is therefore important to see that the questions that arise in connection with the application of the law are

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[6] See, for example, Meester et al. "On the (Ab)Use of Statistics in the Legal Case Against Lucia de B.", 2006, and Tillers, "Introduction", 1997, pp. 1879 ff. (Cf. Colyvan and Regan, "Legal Decisions and the Reference-Class Problem", 2007.)

[7] See, for example, Cohen, *The Probable and the Provable*, 1977, pp. 13 ff.

[8] Legal texts on causation frequently contain claims such as: "When assessing expert evidence on causation, the legal concept of causation requires the court to approach the matter in a distinctively different manner from that which may be appropriate in either philosophy or science, including the science of epistemology" (Spigelman CJ in *Seltsam Pty Ltd v McGuinness*, 2000, at 142); and "the legal concept of causation is not based on logic or philosophy. It is based on the practical way in which the ordinary man's mind works in the everyday affairs of life" (Lord Reid in *McGhee v National Coal Board*, 1973, at 5).

legally motivated questions about legally relevant conditions in the world. They are not necessarily the same questions as those that arise in a scientific context. Consequently, answers to scientific questions do not automatically serve as answers to legal questions. When they do not, to accept scientific answers to legal questions straight off is to commit what sometimes has been referred to as a *Type III-error*: to accept (or give) *the right answer to the wrong question*.[9] In Section 1.2 below, I present a framework distinguishing between two kinds of difference between legal and scientific questions – a framework that can, I think, be put to rather broad use as a way of conceiving of the meeting between law and science and some of the problems that arise in it.[10] The first of these, which I call *epistemological differences*, consists of differences between legal and scientific standards of proof. The second, which I call *ontological differences*, consists of differences between legal and scientific categorizations of the world.[11] This framework, which I call "the EOD framework", is then

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[9] A more technical definition of Type III errors as "the probability of having solved the wrong problem when one should have solved the right problem" can be found in Mitroff and Featheringham, "On Systemic Problem Solving and the Error of the Third Kind", 1974. Less technical understandings were deployed thereafter by, for example, Kriebel, et al. "The Precautionary Principle in Environmental Science", 2001, p. 874, and Wahlberg, "Rätt svar på fel fråga", 2010, p. 895.

[10] I have previously presented this framework in Wahlberg, "Rätt svar på fel fråga", 2010.

[11] It should be observed that my distinction between legal and scientific questions is different from the distinction(s) sometimes made between matters of law and matters of fact. The legal and scientific questions that I discuss are best taken to be questions about facts. However, as will be discussed in this monograph, legal and scientific questions about facts differ from each other with respect to the standard of proof adopted and the entities they are about. These differences depend, in part, on the content of the legal questions and hence on matters of law. Even so, the legal questions are themselves (legally motivated) questions about the world. (The distinction between matters of fact and matters of law is itself drawn differently, depending on the function it has in the legal system

used as a basis of a discussion about the extent to which questions that arise in the application of legal rules can be answered by means of answers to *other*, scientific questions.

1.2 The EOD Framework (The Framework of Epistemological and Ontological Differences)

1.2.1 Epistemological Differences

Empirical statements are generally underdetermined by the available evidence.[12] It follows that both law and science must relate to uncertainty and make use of standards of proof of some sort. In law the applicable standard of proof varies with the matter at issue. For example, criminal law normally requires the defendant's guilt to be proven beyond reasonable doubt. In tort law it is often sufficient that a causal relation between the behaviour grounding responsibility and the damage is proven by a preponderance of the evidence. These standards state what level of empirical certainty is required for the application of the law in a particular case; they depend *inter alia* on the seriousness of incorrect judgments. For example, the rigid standard of proof in criminal cases reflects the view that it is much worse to convict someone who is innocent than it is to acquit

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and the practical/theoretical interests of the researcher. For discussion of the distinction in Sweden, see Lindell, *Sakfrågor och rättsfrågor*, 1987.)

[12] General theories ranging over an infinite number of objects are notoriously underdetermined by a finite body of evidence, but already singular empirical statements are strictly speaking underdetermined by sense data (See Duhem, *The Aim and Structure of Physical Theory*, 1991 (1906), pp. 180 ff. and Quine, "Two Dogma's of Empiricism", 1951, pp. 39 ff.). Descartes' evil demon is a rather extreme, but vivid, expression of the problem of underdetermination. (Descartes, *Meditations on First Philosophy*, 1989 (1641), pp. 79 f.)

someone who is guilty. In a tort case, the law is supposed to be neutral with respect to the contending parties. Unless other legally relevant factors affect the standard of proof,[13] incorrect verdicts in either direction are equally bad; hence the application of a lower standard in this context.

Science often requires a rather high level of certainty in inferences to the existence of a particular association or some other state of affairs. With statistical terms, science often focuses more on the reduction of so-called Type I errors (which, simply put, are inferences to, for example, associations that do not obtain) than on the reduction of so-called Type II errors (which instead are failures to infer associations that actually do obtain).[14] The scientific use of strict standards of proof can be explained by the function that these standards are given in assuring the reliability of what is accepted as scientific knowledge.[15] The fact that something fails to qualify as scientific knowledge does not automatically imply that the contrary statement qualifies as such knowledge; and, because of this asymmetry, in a scientific context it is often seen as worse to infer the existence of a non-existent association than it is to suspend judgment and so – temporarily, at least – fail to infer the existence of an existing association. This possibility of suspending judgment has therefore been said to explain the scientific preference for Type II over Type I errors.[16] As in law, however, the scientific standard of proof varies from one scientific context to another.[17] Sometimes, inferences are made to guide certain practical actions and relate

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[13] Another factor often regarded as important in this respect is the possibility of securing evidence; see e.g. Heuman, *Bevisbörda och beviskrav i tvistemål*, 2005, pp. 166 ff.

[14] See, for example, Barrett and Raffensperger, "Precautionary Science", 1999, p. 112, Hansson, "Can We Reverse the Burden of Proof?", 1997, p. 226 and Shrader-Frechette and McCoy, *Method in Ecology*, 1993, pp. 156 ff.

[15] Hansson, "Can We Reverse the Burden of Proof?", 1997, p. 225.

[16] Levi, "On the Seriousness of Mistakes", 1962, pp. 62 f.

[17] See, for example, Altman, "Statistics and Ethics in Medical Research", 1980, pp. 1612 ff. for discussion of factors of relevance already to the choice of the statistical level of significance. (Cf. note 3 above.)

directly to some particular practical objectives; they are not merely a means to attain knowledge. Failure to infer the existence of an empirical fact in these contexts will often have some consequences of relevance to the objectives in play. Hence such failure does not merely amount to a suspension of judgment.[18] In these contexts, then, other standards are often appropriate.

The standard of proof required in a particular legal context will often differ from the standard required in a particular scientific context. The fact that legal and scientific standards of proof differ, is no more remarkable than the fact that the standards of proof required in distinct legal (or distinct scientific) contexts differ. The difference in standards of proof is, at least to a large extent, a result of the fact that the inferences that these standards permit are used for different purposes, and that therefore different things are at stake. Particular practical objectives are, for example, generally highly important in a legal context. Legal procedural rules, moreover, impose an obligation on the court to reach a judgment – and also, normally, seriously constrain the possibility of subsequently reversing it. Consequently, an omission to infer the existence of an empirical fact will, in a legal context, amount in practice to an inference to its non-existence. It can be seen, then, that there is normally no correspondence here with the scientific

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[18] Levi relates the possibility of suspending judgment to the process of "accepting as true", which he distinguishes from the process of "acting as if" (Levi, "Must The Scientist Make Value Judgments?", 1960, p. 351). With reference to the relevance of practical utilities, kindred distinctions have been made between "basic sciences" and "applied science", and between science (e.g. medical sciences) on the one hand and *applications* of science (the *art* of medicine) on the other. (See, for example, Niiniluoto, "Aim and Structure of Applied Research", 1993, pp. 2 ff. and p. 9). The here presented EOD-framework is applicable to the meeting between law and scientific contexts of all these kinds and the discussion in this monograph will not rely on these distinctions. However, as explained in Section 1.2.3, the characterization of scientific knowledge given here will focus on the kinds of entity that are relevant in scientific contexts where practical objectives are relatively unimportant.

possibility of suspending judgment, and to the ensuing asymmetry between inference and non-inference.[19] Nor are the particular practical objectives that are relevant and influence the applicable standard of proof in some scientific contexts normally the same as those that are relevant in a particular legal context.

In this monograph I will refer to differences between legal and scientific standards of proof as *epistemological* differences. Epistemological differences reflect the different purposes for which a conclusion is to be used, and the considerations that are relevant in a legal, as compared to scientific, context. Because legal standards of proof are designed for legal purposes, it is reasonable to give priority to these standards when the context is legal. This implies that a scientific conclusion, reached by a different standard, can be irrelevant in a legal context. Thus, if the scientific standard is higher than the legal standard, the fact that something is not scientifically proven does not imply that it is not legally proven. Conversely, if the scientific standard of proof is lower than the legal, the fact that something is scientifically proven does not imply that it is also legally proven.

A number of legal and philosophical scholars have recognized the existence of what I call epistemological differences between law and science. Among those who have seen the contextual relativity of standards of proof, many tend to agree that legal standards of proof should – at least, in theory – be given priority in a legal context.[20]

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[19] See, for example, Haack, S., "Truth and Justice, Inquiry and Advocacy, Science and Law", 2003, p. 108, who points out that a fundamental difference between courts and scientists is that the latter, unlike the former, can suspend judgment.

[20] The principle that legal standards of proof should be given priority in a legal context is explicitly advocated by Carl Cranor in Cranor, *Regulating Toxic Substances*, 1993, pp. 5 ff. The same idea can be found in, for example, Barrett and Raffensperger, "Precautionary Science", 1999, pp. 117 f., Meeran, "Scientific and Legal Standards of Proof in Environmental Personal Injury Cases", 1992, pp. 671 f., Peel, *The Precautionary Principle in Practice*, 2005, pp. 40 f. and Shrader-Frechette and McCoy, *Method in Ecology*, 1993, pp. 156 ff. It is not, however, entirely uncontroversial: cf.

This suggests that much will be gained already by creating greater awareness of these differences and the reasons underlying them. Yet, even if it is acknowledged that legal standards of proof should be given priority, it is another matter to ask how this can be done. For example, it has been argued that the result of years of repeated application of scientific standards of proof cannot be appropriately reinterpreted in accordance with legal standards of proof in any simple way.[21] Furthermore, and as already mentioned, it has been suggested that the difference between legal and scientific standards of proof amounts to more than a quantitative difference in the degree of probability required.[22] However, qualitative differences are likely to give rise to additional problems when legal standards of proof are applied to scientific material. Further research into these differences, and how they should be bridged, is needed.

1.2.2 Ontological Differences

Differences of aim and function do not give rise only to differences with respect to the standards of proof required to answer legal and scientific questions. In addition, such differences affect the very notions employed in legal and scientific contexts. Thus, it is obvious that scientifically employed notions such as "benzene molecules", "quarks" and "electro-magnetic force", differ from legally employed notions such as "environmentally hazardous activities",

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Black, B., "Evolving Legal Standards for the Admissibility of Scientific Evidence", 1988, pp. 1508 ff. Discussion of different kinds of position with respect to the general validity of scientific conclusions can be found in Levi, *Gambling with Truth*, 1967, pp. 3 ff.

[21] Hansson, "Can we Reverse the Burden of Proof?", 1997, pp. 227 f.

[22] See Cohen, *The Probable and the Provable*, 1977, Brilmayer and Kornhauser, "Review: Quantitative Methods and Legal Decisions", 1978, Ekelöf, *Rättegång IV*, 1992, pp. 123 ff., Gärdenfors et al. *Evidentiary Value*, 1983, and Wright, "Causation, Responsibility, Risk, Probability, Naked Statistics and Proof", 1988, pp. 1049 ff. Cf. Kaye, "The Laws of Probability and the Law of the Land", 1979. See also Edelstam, *Sakkunnigbeviset*, 1991, p. 384.

"negligence" and "right". It is less obvious what the difference between these scientific and legal notions consists in.

Discussion of legal ontology has tended to focus on the question whether legal notions refer to something in the world at all; and – if they do – *how* they refer. The referents of many legal notions have been said not to *really* exist as electrons, chromosomes and bacteria do, or at least to exist in a way which is qualitatively different from the existence of some presumably more natural entities.[23] I acknowledge the possibility that the referents of some legal notions (such as, perhaps, "right" and "norm") differ from the referents of some scientific notions (such as "electron") in these respects. However, I do not think that a general dividing line between legal and scientific notions is marked by the status of existence of their referents.[24] More importantly, it is not with differences like these that

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[23] See, for example, Olivecrona, "Legal Language and Reality", 1962, and Moore, "A Naturalist Approach to Legal Ontology", 2002, pp. 632 ff, for overviews of some of these discussions. A famous attempt to account for the existence of so-called institutional facts is made by John Searle in *The Construction of Social Reality*, 1996 (1995). On Searle's analysis (p. 28 and passim), institutional facts exist only within systems of constitutive rules according to which a "brute fact" X (e.g. a particular piece of paper) counts as Y (money) in C (Sweden). (See also Anscombe, "On Brute Facts", 1958, and MacCormick and Weinberger, *An Institutional Theory of Law*, 1986.)

[24] Some legal notions, such as perhaps the notion of "rights", may lack direct referents and thus have an instrumental rather than descriptive function; the referents of some scientific notions, such as "quarks" (or, with hindsight, "phlogiston") can likewise be called in question. Moreover, many other legal notions – e.g. "environmentally hazardous activity" and "material damage" – seem to me to describe something real, as much as scientific notions do. Nor is perspective-relativity unique to legal notions. It is generally recognized that scientific notions, too, develop and are employed relative to a theoretical tradition and framework. (See e.g. Kuhn, "The Natural and the Human Sciences", 1998 (1989), pp. 131 f. for discussion of the theory-relativity of both social concepts and concepts of the natural world.) It should also be observed that the possibility that some scientific notions indeed refer to perspective-neutral, brute facts does not make the distinction between

the present investigation is concerned. In this monograph, I am interested in ways in which differences between legally and scientifically relevant entities impede the answering of legal questions by the application of scientific information. Some examples of legal notions that are of immediate relevance to this discussion are "negligent behaviour", "activity", "causal relation" and "material damage". Here I will simply take it for granted that these legal notions, as well as the here relevant scientific notions, *do* refer to something that is sufficiently real to make this investigation meaningful.[25] What I am interested in is the fact that the legal

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brute and institutional facts a general distinction separating legal and scientific notions. (See also Section 2.4.)

[25] My ontological interest is thus not an interest in what really exists, but an interest in the different categories that are fruitful given particular theoretical perspectives. This interest, and the recognition of theory-relative entities, is not necessarily incompatible with the metaphysical position that only some fundamental kind of entity *really* exists, holding that theory-relative entities are (or should be) reducible to the instances and constellations of this kind of entity that reflect the parts of its behaviour that are relevant given a particular perspective. In keeping with this argument, our conception of less fundamental kinds of entity may be explained by the fact that the behaviour of the fundamental entities is more easily, or more efficiently, captured in terms of it. Thus events in an ant hill are, at least at present, better captured in terms of different kinds of ants and their roles than they are in terms of, say, electrons or cells. Now, even if ants, populations, mountains, activities, material damage and other macro-level entities and "patterns" of behaviour indeed are less fundamental, it may nevertheless be justifiable to speak of them as existent in a "mildly realistic" sense (See Dennett's discussion of mild realism and patterns in "Real Patterns", 1991, pp. 29 ff.). Whether we are "strong" or "mild" realists about them will in part depend on whether we believe that their causal powers are reducible to the powers of more fundamental entities. (See also Section 4.3.) For the purposes of the present study, it suffices that a mildly realistic attitude to legal (and scientific) entities is adopted. Whether they really exist in a strong sense is therefore a question on which I will remain agnostic. Either way, the difference between entities that are "strongly real" and entities that are possibly merely "mildly real" does not mark the dividing

notions generally tend to refer to *something other* than the referents of scientific notions. More precisely, and as will be discussed at more length in the following chapters, the individual referents and/or the extensions of legal notions will often differ from the individual referents and extensions of any scientific notion. As a result of these differences legal and scientific notions pick out different kinds of entity in the world. They therefore presuppose different categorizations of that world. This is what I mean by "ontological differences" between law and science.

Compare, as a concrete example, the (legal) notion "activity" in chap. 2 sec. 3 of the (Swedish) Environmental Code (SFS 1998:808) and the (scientific) notion "benzene molecule". Both of these notions seem to refer to something[26] in the world. Some legally relevant activities will undeniably involve benzene molecules, but the class of activities will not be identical with the class of benzene molecules (or benzene for that matter). Some benzene molecules will not be involved in any activity at all, and many activities will not include any such molecules. Moreover, an individual activity will not coincide with an individual benzene molecule; it may also include, say, technical equipment, radiation and other chemical substances.

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line between legal entities and scientific entities but rather the difference between legal and (at least most) scientific entities, on the one hand, and strongly existent entities – whether scientifically recognized or not – on the other. It can be noted in passing that whereas Searle's theory suggests an explanation of the way brute facts are assigned particular functions in particular contexts, it does not engage with the debate over whether all, or merely some, "brute facts" exist in the strong sense.

[26] It could be complained that unlike "benzene molecule", "activity" refers to a process and not to a thing. As far as I can see, this difference in category is not immediately relevant to the discussion in this monograph. Besides, it is controversial. Thus, according to Quine (*Word and Object*, 1996, p. 171): "Physical objects, conceived thus four-dimensionally in space-time, are not to be distinguished from events, or in the concrete sense of the term, processes." For extensive discussion, see Hansson Wahlberg, *Objects in Time*, 2009, pp. 50 ff.

So, although both the individual referents and the extensions of the two notions "benzene molecule" and "activity" may overlap, they will not coincide. That a legal notion differs from a scientific notion in this respect should come as no surprise; distinct legal (and scientific) notions differ from each other in these respects too. However, as will be discussed at greater length in Chapter 2, the boundary of the legally relevant entity "activity" is a result of legally relevant considerations pertaining to the appropriate scope of legal responsibility. These considerations, which are clearly important to the legal categorization of the world, are not relevant in the same way in a scientific context. Outside the legal context "activity", as it is understood in chap. 2 sec. 3, Environmental Code, is not, therefore, a recognized entity. Because the considerations underlying the legal and scientific categorizations of the world generally differ, these differences can be expected to result in far-reaching differences in legal and scientific ontology.

The fact that legal and scientific categorizations are different does not imply that they are incompatible. Quite which categorizations are meaningful is relative to the considerations that are relevant in each context. If some legally relevant considerations pertaining to, say, moral or economic factors are irrelevant in a scientific context, a categorization which is a function of these considerations is typically not meaningful there either. This does not necessarily mean that it will be denied, from the scientific point of view, that such a categorization *would* be meaningful in a context in which these considerations *were* relevant. The different categorizations may very well be compatible, then. Nor does the acknowledgment of various perspectives and categorizations imply a denial of a single and objectively existent world; it obliges us merely to recognize that this world can be fruitfully parsed in many different ways.[27] The problems to be discussed in this monograph

[27] Recognition of multiple categorizations of the world does not oblige one to regard *all* these categorizations as adequate. (Mitchell, *Unsimple Truths*, 2009, p. 14 and Munn, "Introduction", 2008, p. 12.)

are, then, problems that arise as the result of different, but not necessarily incompatible, categorizations of the same world.[28]

My use of the term "ontology" will perhaps appear less similar to the term's philosophical usage than to the way it is used within computer science, where it has been characterized as a "specification of a conceptualization".[29] This characterization, which has been deployed in the context of Artificial Intelligence and Law, is often contrasted with the existential connotations that the term "ontology" typically carries in a philosophical context.[30] Whereas I remain agnostic about whether legally and scientifically relevant entities *really* exist,[31] and whereas I acknowledge the possibility of different but compatible categorizations, it should be observed that the "ontological differences" that I will discuss are neither merely terminological nor, apparently, merely conceptual. They are not merely terminological since they imply that different individuals and kinds are indeed recognized within different theoretical frameworks. These different categorizations normally work rather well for their purposes and hence reflect fruitful ways to parse the world relative to particular perspectives. Because they are, as a result, manifestations of the world *and* the different perspectives that are applied to it, they can hardly be discarded as merely conceptual either.[32] In this monograph I take no side in the philosophical debate about the more precise existential status of the entities demarcated

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[28] Mitchell (*Unsimple Truths*, 2009, p. 13) argues for "a pluralist-realist approach to ontology, which suggests not that there are multiple worlds, but that there are multiple *correct* ways to parse our world, individuating a variety of objects and processes that reflect both causal structures and our interests". See also Searle, who very explicitly assumes the existence of an external reality which is independent of our representations: *The Construction of Social Reality*, 1996 (1995), p. 155.

[29] See, for example, Gruber, "A Translation Approach to Portable Ontology Specifications", 1993, p. 199.

[30] See, for example, Valente, "Types and Roles of Legal Ontologies", 2005, p. 66 and Munn, "Introduction", 2008, p. 14.

[31] See note 25 above.

[32] Cf. Dupré, *The Disorder of Things*, 1993, p. 36.

by these categories, but the discussion I present is sufficiently close to this and other ontological discussions to motivate the notion that these entities are referred to in ontological terms.[33]

Thus, like legal standards of proof, the legal ontology is relative to legally relevant considerations; and just as legal standards of proof should be given priority over scientific standards in a legal context, legal ontology should be given priority over scientific ontology when the context is legal (as I shall explain at greater length below).[34] In a legal context, it must therefore be observed that it is, for example, the *legally* relevant relation (R_{jur}) between a particular *legally* relevant cause (c_{jur}) and effect (e_{jur}) which is at issue. This is so irrespective of whether this relation is scientifically relevant. This priority of the legal ontology is not as self-evident at it may, perhaps, seem. As we shall see in Chapter 2, it leads to some unexpected conclusions, and in practice it has not always been respected.

Like epistemological differences, ontological differences tend to affect the importance that scientific answers have to legal questions. Thus, where the law asks for a relation R_{jur} between c_{jur} and e_{jur}, the legal relevance of a scientific finding pertaining to the existence of a relation R_{sci} between c_{sci} and e_{sci} will hinge not merely on the possible differences between the applicable standards of proof, but also on the possible differences between R_{jur}, c_{jur}, and e_{jur}, on the one side, and R_{sci}, c_{sci} and e_{sci}, on the other.

1.2.3 Application of the Framework

The EOD framework should provide a useful way to conceive of the meeting of law and science in many contexts. Presumably, it applies to many other interdisciplinary meetings, too. In a particular case,

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[33] It can be noted that many philosophers do not seem content with a mild realism with respect to these kinds of entity (cf. note 25 above) See, for example, the "promiscuous realism" advocated by Dupré, *The Disorder of Things*, 1993, pp. 17 ff. See also Mitchell, *Unsimple Truths*, 2008, p. 13.

[34] See Chapter 2.

failure to pay attention to the epistemological and/or ontological differences between law and science may lead to a legally inadequate result.[35] Recognition of these differences, and of the priority of the legal standards of proof and ontology, is therefore important in the actual application of the law. Some examples of the framework's usefulness in this respect will be given in passing. In this monograph, however, I shall use the EOD framework to assess the way in which differences between legal and scientific ontology *systematically* reduce the impact of the law in the long run. If the entities that legal questions are about differ from those that scientific information is about, it is reasonable to ask: To what extent can the existence of legally relevant entities be established through the application of scientific information about *other* entities? If it turns out that the existence of certain legally relevant entities cannot be

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[35] Where, and to what extent, problems due to epistemological and ontological differences arise in the application of the law depends *inter alia* on the relevant procedural rules. For example, the jury system has led to a separation of "questions of fact" from "questions of law" (in the sense of common law, cf. note 11 above), as the result of which many legal elements are eliminated from the questions the jury addresses. As a result, failure to recognize the ontological differences between law and science is less likely in such a system than it is in a system like the Swedish one, where the court decides the case in a more holistic manner. In jury systems too, however, the questions of fact the jury answers will often contain some inseparable legal element, e.g. a legally relevant understanding of causation, with respect to which these problems may arise (see the discussion of the legal notion of causation in Section 3.3.3 below). As another example, some rules of admissibility give the judge the role of a gate-keeper with respect to scientific evidence, so that the judge decides what scientific evidence shall be admitted to assist the jury in the trial of fact. What I call epistemological differences between law and science, therefore, will often need to be dealt with before the evidence reaches the jury. Although the applicable procedural rules will, then, affect the extent and manner in which problems due to epistemological and ontological differences arise in a particular case, they will not normally make them disappear. More importantly, they will not affect the more *systematic* difficulties connected with ontological differences that are discussed in this monograph.

established in this way, some legal rules may be less efficient than had previously been assumed. So differences between legal and scientific ontology may systematically reduce the impact of the law even if these differences are recognized and the priority of the legal ontology respected. In this monograph, it is thus, primarily, the systematic effects of differences between legal and scientific *ontology* which are of interest. However, epistemological differences, too, are relevant to this investigation. This is so because the strength of the standard of proof is likely to determine, in part, what entities can be established. If the legal standard of proof is lower than the scientific standard, more entities will presumably be establishable by means of the former. Because the legal standard of proof should be given priority in a legal context, a study of the extent to which legally relevant entities can be established by means of scientific knowledge must take the epistemological differences between law and science into account.[36]

The EOD framework can thus be used for different purposes. Just what epistemological and ontological differences are relevant within a particular application of the framework depends on the purpose for which the framework is used. The present investigation's interest in the possibility of answering legal questions through the application of scientific information is accordingly relevant in this respect. As was illustrated in Section 1.2.1 and will be discussed at greater length below, there is not one, but a number of different scientific contexts.[37] When a legal question is answered through the application of scientific information, this is done by means of the information that is available in the particular case. Hence it is the categorizations underlying this information that are of relevance to the possibility of answering the legal questions in such a case. These scientific categorizations may be relative to a particular discipline, theory or even to a particular scientist. In assessments of

[36] Similarly, and as is illustrated by the discussion in Sections 6.6.1 and 6.7.1 below, ontological differences should be relevant to studies of epistemological differences between law and science.

[37] See Section. 2.4 and Chapter 4.

the application of scientific information in particular cases, differences between legal categorizations and such *specific* scientific categorizations can often, presumably, be fruitfully analyzed within the EOD framework at a relatively high level of detail. In the present investigation, however, which focuses on systematic difficulties rather than those that arise in a particular case, such specific differences between particular legal and scientific contexts are of less interest. Instead, a characterization of scientific categorizations which reflects *general* and legally relevant characteristics and limits of science is needed.

"Scientific knowledge", or, where appropriate "scientific information", will in this monograph refer to theories, hypotheses and other propositions which are, from a scientific point of view, regarded as confirmed; so such knowledge is understood as the outcome of scientific standards of proof.[38] As the discussion in Section 1.2.1 has shown, the applicable scientific standard of proof varies from one scientific context to another and depends on the objectives at stake. Thus, in at least some scientific contexts practical objectives affect the standard of proof as well as the kinds of entity that are relevant and possible to establish. The characterization of scientific knowledge in this monograph will focus predominantly on the kinds of entity that are relevant in scientific contexts where practical objectives are relatively unimportant. The reason for this focus is that the kinds of entity – e.g. the kinds of causal relation – which are established in these contexts are normally important factors affecting the possibility of making inferences in scientific contexts where practical objectives are immediately relevant, too.[39]

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[38] Because confirmation does not entail truth, what in this context is referred to as scientific knowledge is not necessarily true. It can be noted that although the standard notion of knowledge, dating back to Plato, is that of true, justified belief (Dancy, *Introduction to Contemporary Epistemology*, 1985, p. 23 and p. 35.), the *term* "knowledge" is often used – as it is here – in a more relaxed manner. (See, for example, Munn, "Introduction", 2008, p. 8, on the use of the term in information science.)

[39] See also Sections 4.4.4 and 5.3.2 below and note 18 above.

This focus will not, therefore, threaten the validity of the investigation's conclusions about the possibility of establishing legally relevant states of affair by means of other kinds of scientific information. Instead, it will make the discussion more manageable and enable a critical assessment of the extent to which other kinds of entity, including those that are relevant in other scientific contexts, can be established through the application of legal standards of proof.[40]

Similarly, there is not one but a number of different legal frameworks and contexts. Just what considerations qualify as legally relevant, what impact they should be given, and what constitutes an appropriate balancing of them, is a function of the society and the legal context in which they are made – and is furthermore relative to different theories of law. Also, within a particular legal context it is often a matter of debate just what the legal ontology precisely consists in. My ambition is to keep the discussion as generally applicable as possible across different contexts and theories. Like the characterization of scientifically relevant entities, the characterization of legally relevant entities must therefore be given in relatively abstract terms.

The parts of the legal ontology that will be given special consideration in this monograph are demarcated by the investigation's focus on legal questions about causation. As was said in Section 1.1, I am particularly interested in legal questions about causation raised by the application of rules serving to counteract

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[40] The characterization of scientific knowledge given here, which typically applies to the possible outcome of rather strict standards of proof, will moreover have the benefit of applying to "scientific knowledge" as it has often been conceived in legal contexts. A well-known example is the case *Daubert v Merrell*, 1993, in which the court established that a pertinent consideration (although not a necessary requirement) in determining whether a theory or technique is scientific knowledge is whether it has been subject to peer review or publication, where strict standards typically apply (*ibid* at 593). This is not necessarily a desirable requirement (see the discussion of epistemological differences between law and science in Chapter 1); nevertheless it is in fact often relied upon.

detrimental impact of human behaviour on human health and the environment. It is thus the categories underlying these rules and questions in Swedish law that I plan to explicitly contrast with scientifically relevant categories here. The more fundamental discussion about the role of science in a legal context is, however, relevant to the use of scientific knowledge in answering questions that arise in the application of other rules, too. Many of the features of the discussed categories that are relevant here are furthermore characteristic of the categories underlying questions about causation as they arise in other legal contexts.[41] Much of what is said in this monograph will therefore be of relevance to the interstice between law and science in general, and for the answering of legal questions about causation by means of scientific information in particular.

1.3 Material, Method and Interdisciplinarity

The present investigation is *about* law and science *in* legal science and philosophy. It raises questions that belong to a number of different branches of both law and philosophy, and it applies to the meeting between law and various scientific disciplines. Three fundamental and interrelated ideas have been particularly important to the investigation. These are: 1) the belief that nature is highly complex; 2) the conviction that what is rational is relative to goals and values; and 3) the view that the merits of legal rules are relative to the rules' actual efficiency. The investigation draws on, and

[41] Theories of e.g. the legal notion of causation normally stretch across the boundaries of legal contexts and systems (see Section 3.3.3). Moreover, international agreements, not least within the European Union, have led to the harmonization of many material rules and the questions to which they give rise. Whereas I discuss mainly causal questions in Swedish tort and environmental law, many of the difficulties discussed here will, therefore, arise in the course of answers to many causal questions in e.g. Swedish criminal law and non-Swedish tort and environmental law.

combines, the results of research from a number of different fields, much of which relies to some extent on these ideas, too. In this section, I will present some of this research and explain how it relates to the present investigation. I will also offer some general methodological reflections on the interdisciplinary character of the present study.

A belief in nature's complexity underlies the works of many contemporary philosophers of science.[42] It is generally recognized that human representations and investigations of this complex nature are necessarily partial.[43] Just what parts it is purposeful to investigate, and in what ways, depends on the interests and goals of the researcher; different interests require different approaches. The insight that nature is complex, together with the recognition of goal-relativity, has led many to argue for a pluralistic approach to both nature and scientific method. Part of this argument has been ontological. In particular John Dupré and Sandra Mitchell have argued that there are many valid ways to parse the world and that the merits of each must be assessed relative to the interests that apply in the particular context.[44] Whereas Mitchell mainly discusses differences within science, Dupré has also compared at length the differences between the categorizations that are purposeful in science with those that are purposeful in ordinary life.[45] In this monograph, I export this discussion to the legal context; I apply and develop it in connection with the differences between legal and scientific categorizations. I use this discussion both as a means to understand the interdisciplinary meeting that takes place when legal

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[42] See, for example, Cartwright, *How the Laws of Physics Lie*, 1983, p. 19, Dupré, *The Disorder of Things*, 1993, p.1 and Mitchell, *Biological Complexity and Integrative Pluralism*, 2003, p. 8 and pp. 13 ff.
[43] See, for example, Ashby, *An Introduction to Cybernetics*, 1957 (1956), p. 107, Mitchell, *Unsimple Truths*, 2009, p. 31 Munn, "Introduction", 2008, p. 12 and Searle, *The Construction of Social Reality*, 1996 (1995), p. 176.
[44] Dupré, *The Disorder of Things*, 1993, pp. 17 ff. and Mitchell, *Biological Complexity and Integrative Pluralism*, 2003, pp. 13 ff. and pp. 179 ff.
[45] Mitchell, *Biological Complexity and Integrative Pluralism*, 2003, and Dupré, *The Disorder of Things*, 1993, pp. 18 ff.

questions are answered by means of scientific knowledge and to analyze the epistemic problems that arise in it.

Lying at a tangent to this discussion about the ways in which the world can be divided are discussions centring on the very *construction* of socially relevant categories and their content. The examination of these issues to date has had a considerable impact on legal theory. For example, Elizabeth Anscombe's and John Searle's philosophical theory about the construction of institutional facts has been used by Neil MacCormick and Ota Weinberger to develop an institutional theory of law.[46] The predominantly sociological discussion of the way in which our categorizations of gender, race, rape, sexual disposition, and so forth, affect the way we act in the world, and thereby interact with and affect the actual content of the world, has likewise provided fruitful tools for analyzing the interaction of law and the objects of legal regulation.[47] These dimensions of the construction of social categorizations are interesting in their own right, and recognition of them is not in itself in conflict with the notion that different categorizations are relevant in different contexts.[48] In this monograph, however, it is the latter dimension of socially – and scientifically – relevant categories that is to be investigated.

As was mentioned above, many have observed that values are relevant in science and that scientific conclusions about empirical matters are necessarily underdetermined by the available evidence.[49]

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[46] See Section 1.2.2, note 23 above.

[47] See, for example, Andersson, *Hans (ord) eller hennes?*, 2004 and Smart, *Law Crime and Sexuality*, 1995. See also Delaney, *Law and Nature*, 2003, for a discussion of the legal construction of nature. Cf. the discussion of "dynamic nominalism" in Hacking, *Historical Ontology*, 2002, p. 2, p. 40 and pp. 99 ff.

[48] It is another matter that many social constructionists appear unwilling to say that these categorizations reflect something about the world, or imply that certain boundaries are drawn in the external reality. As discussed in Section 1.2.2., the present investigation adopts a more realistic attitude towards the categorizations discussed here.

[49] See Section 1.1, notes 2 and 3, and Section 1.2.1 note 18 above

These insights have led to a questioning of the old – and convenient – dichotomy between factual science and normative policy. It has been observed *inter alia* that scientific standards of proof need not be appropriate in contexts of policy, and that many seemingly scientific questions that are relevant to policy fall outside the actual scope of science.[50] As a result, more nuanced approaches to the meeting between science and policy have been sought and suggested.[51] For example, it has been called into question whether the common separation of (scientific) risk assessment and (political) risk management can and should be maintained.[52] The present investigation applies some of the results of these discussions to the meeting between science and *law*, which in many respects is a more theory-laden analogue of the meeting between science and policy. As seen in Section 1.1, the meeting of law and science has also been much discussed, and some problems that arise in it have now been pointed out.[53] The present investigation introduces the EOD framework both as a means of conceiving of the impact of goal-relativity in this meeting and to draw a map of the "extra-scientific" domain of legally relevant states of affairs.

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[50] See, for example, Barrett and Raffensperger, "Precautionary Science", 1999, and Weinberg, "Science and Trans-Science", 1972.

[51] See Shrader-Frechette, *Risk and Rationality*, 1991, for a comprehensive discussion.

[52] Vareman and Persson, "Why Separate Risk Assessors and Risk Managers?", 2010.

[53] See references in Section 1.1, notes 5 and 6 and Section 1.2.1 note 20 above. A discussion of law and science which deserves particular mention in this respect is Carl Cranor's *Regulating Toxic Substances*, 1993. Cranor's book examines systematically the usefulness of *ex ante* and *ex post* approaches to the regulation of chemicals; it also discusses possible ways to understand and apply legal standards of proof to scientific material. Hence, like the present investigation, it applies the perspective of goal-relativity to epistemic difficulties that arise in the establishment of causal relations. However, Cranor's investigation primarily concerns the correct handling of what I have called *epistemological differences* between law and science.

The need to take the actual efficiency of legal rules into account in the design of regulation is often stressed.[54] A regulation may appear to be just and theoretically impeccable but nevertheless turn out to be ineffective when applied because it makes simplistic assumptions and ignores the complexity of the world and/or the possibility of obtaining legally relevant knowledge of it. The possibility, examined here, of establishing legally relevant causal relations by applying scientific knowledge is an important factor affecting the efficiency of many legal rules. It therefore deserves systematic assessment. Recognition of goal-relativity is relevant in this respect, because it allows for an assessment of the *legally* relevant limits of scientific results.

Many of the interdisciplinary issues to be discussed in this monograph have thus been raised and dealt with before, and are now in themselves relatively well entrenched research fields. Yet the ways in which these issues are combined and discussed here is new and cannot be accommodated within any single, established area of research. As a result, the investigation to be conducted will to a large extent lack the features of the paradigmatic, normal puzzle-solving which Thomas Kuhn famously said is so characteristic of normal, mature science.[55] As Kuhn himself later pointed out, much of the research conducted in the social sciences lacks this characteristic,[56] an observation which certainly applies to much legal science too. According to Kuhn, this is not necessarily due to these sciences' immature or "pre-scientific" status, but can instead be explained by the distinctive features of their objects of study which change with time and hence require a flexible approach.[57]

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[54] See, for example, Brooks et al. *Law and Ecology*, 2002, pp. 122 f., Gelpe, and Tarlock, "The Uses of Scientific Information in Environmental Decisionmaking", 1974, p. 373, Gipperth, *Miljökvalitetsnormer*, 1999, pp. 10 ff. and Westerlund, *Miljörättsliga grundfrågor 2.0*, 2003, pp. 95 ff.

[55] See, for example, Kuhn, *The Structure of Scientific Revolutions*, 1962, pp. 35 ff.

[56] Kuhn, "The Natural and the Human Sciences", 1998 (1989), pp. 133 f.

[57] Kuhn, "The Natural and the Human Sciences", 1991 (1989), pp. 133 f.

Even so, I think that it is important to acknowledge that much interdisciplinary research has some pre-scientific characteristics which cannot be explained away by the internal properties of its objects of study. To begin with, because interdisciplinary research is by definition research located *between* established disciplines and fields, it will typically require the construction of a new theoretical framework to which the research can relate. In the present study, for example, the EOD framework, within which the meeting of law and science can be conceptualized, has this function. Moreover, it is inevitable that interdisciplinary research partly makes use of concepts other than those used in its bridged fields. For example, terms such as "justification", "entity", "individual" and "proposition" already have quite different connotations depending on whether the context is legal or philosophical. Hence already the choice of scientific language becomes an issue in interdisciplinary research. More generally, interdisciplinary research faces the challenge of being set at a tangent to existing paradigms but nevertheless raising different questions, and therefore requiring different approaches, to those that are prevalent within these paradigms. In this light, an interdisciplinary PhD-thesis, which is supposed to be a qualifying piece of work, is something of a contradiction in terms.

Interdisciplinary research cannot straightforwardly adopt the research methods of existing paradigms, then; nor can its virtues and vices be adequately assessed in the light of the particular criteria of some such paradigm. An extra-paradigmatic understanding of science and scientific method which both accommodates interdisciplinary research and explains its particular characteristics would, therefore, be highly useful in the conduct as well as the assessment of such research. The history of the philosophy of science suggests, however, that a generally applicable demarcation criterion which unequivocally distinguishes science from pseudo-science is

very hard, if not impossible, to find.[58] The reason for this is like that underlying the epistemological and ontological differences discussed above – namely, that different purposes and interests require different approaches. Even so, this does not rule out the possibility of identifying a number of criteria of broad methodological relevance on the basis of which science and scientific method can be fruitfully discussed in general terms.[59]

Simply put, a method is the way in which particular material is used. An important factor underlying the choice of method is therefore the *choice of material*. Another important question concerns the precise *information* that this material is used to convey. Answers to this question will involve an assessment of *what aspects* of the information, *at what level of detail*, are required for the question at issue to be answered and conclusions drawn. Also relevant in this respect is the way the material is structured in order to make it as informative as possible. A further important question is *with what strength the conclusion follows* from the material and method being used. A tangential question concerns the *scope of the conclusion* with respect to contexts other than the one under study. Different paradigms, different research questions and different methods provide more or less elaborate answers to these questions, and they typically answer them differently. The questions as such, however, are generally relevant and apply to the methodological choices in the present investigation, too. Some issues that relate to these questions have already been discussed in Section 1.2.3. Others are more appropriately dealt with in connection with the material presented in the following chapters. In the rest of this section I will make some

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[58] Popper's now widely rejected falsifiability criterion is probably the best candidate. (See Popper, *The Logic of Scientific Discovery*, 1992 (1934).) The general need for such a demarcation criterion is illustrated by the fact that some such candidates have found their way into the courtrooms as criteria of the admissibility of scientific evidence. (See, for example, *Daubert v Merrell*, 1993 at 593, and discussion in Haack, "Truth and Justice, Inquiry and Advocacy, Science and Law", 2003, pp. 110 ff.).

[59] Cf. Dupré, *The Disorder of Things*, 1993, pp. 242 f.

additional introductory comments on these questions; these are called for, I think, by the interdisciplinary character of this work.

My characterization of the law and legal questions will be based predominantly on statutes, preparatory works and legal doctrine. The purpose of this characterization is to highlight some of the general features of these questions that can be contrasted with the characteristics of the scientific information that is used to answer them. It should be clear that a characterization of this kind does not require the same level of detail as a characterization intended to serve as a guide to the *application* of the law and these questions. A characterization of legal and scientific notions, moreover, is likely to be more robust across a range of contexts and interpretations if it does not contain more detail than what is necessary for the inquiry at issue. Whereas, for example, case law is important when we are determining the precise boundaries of the legal categories – something that is highly relevant to a study aimed to guide the application of the law – decided cases will, in the present investigation, serve primarily as illustrations.

My characterization of science and scientific knowledge will to a large extent be based on the results of existing research within the philosophy of science. Where appropriate I will use concrete examples, primarily from scientific textbooks, to illustrate the points being made. Philosophical research has also played an important role in the construction of the EOD framework that I use to conceptualize the meeting of law and science. Furthermore, the investigation to be conducted in this monograph largely consists in conceptual analysis which, like other philosophical investigations of this kind, relies on analytical reasoning. However, the purpose of this investigation, as well as affecting the use made of the legal material, also affects the use made of philosophical research. As indicated already in Section 1.2.3, the characteristics of scientific categorizations that interest me are those which, in virtue of their relation to characteristics of legal categorizations, are relevant to the possibility of answering legal questions by applying scientific knowledge. These are not necessarily the same characteristics as those that would be of interest from a strictly philosophical perspective. Similarly, my usage of the words "epistemology" and

"ontology" are not motivated by an interest in what knowledge really is, or by curiosity about what really exists, but instead by my interest in the two important differences between law and science which, because of their close resemblance to these fundamental issues, I use this terminology to refer to. More generally, the investigation could be characterized as an *epistemically oriented comparative conceptual analysis*. So it is not the legal and scientific concepts as such that are of primary interest in this investigation, but the ways in which they relate to each other, insofar that these are relevant to the possibility of answering legal questions by applying scientific knowledge. The importance of goal-relativity which, in part, motivated this investigation is therefore, quite naturally, instantiated in the investigation itself.

This project involved the collaboration of the Department of Philosophy (in the Faculty of Humanities) and the Department of Law (in the Faculty of Law) at Lund University. The thesis is formally a thesis in law, but it has been greatly influenced by the research conducted in the Department of Philosophy. It is therefore appropriate to end this section by briefly relating the project to that philosophical context. In the early 1970s the Lund philosophers Martin Edman and Sören Halldén developed the so-called Evidentiary Value Model for evaluation of evidence – a model influenced by the work of the Swedish law professor Per Olof Ekelöf.[60] Evidential value is, in the model, conveyed by an evidential mechanism between evidence and hypothesis.[61] Contributions to the development of this model were made in the 1980s by *inter alia* Peter

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[60] Edman, "Adding Independent Pieces of Evidence", 1973 and Halldén, "Indiciemekanismer", 1973.

[61] See Sahlin and Rabinowicz, *The Evidentiary Value Model*, 1998, pp. 248 ff. Cf. Cohen's theory of inductive probability in *The Probable and the Provable*, 1977, which builds on the idea that legal evaluation of evidence is qualitatively different from the kind of evaluation that occurs in many other contexts.

Gärdenfors, Bengt Hansson and Nils-Eric Sahlin.[62] Sahlin and some other philosophers later turned their attention to the philosophy of risk, and, in addition to discussing many of the difficulties, mentioned above, that arise at the interstice of science and policy, they developed a theory of "epistemic risk". This theory drew attention to a risk of ignorance that the prevalent focus on scientifically framed outcome risks tends to disguise.[63] Sahlin's former student Johannes Persson, who was one of my supervisors, later argued for an ontological shift in focus from outcome risks to the metaphysically more fundamental "risk objects".[64] From here, it is a short step to an investigation of the ways in which ontological differences between law and science give rise to epistemic difficulties.

1.4 Structure of the Thesis

Subsequent chapters are organized as follows. Chapter 2 explains the legal ontology's distinctness and discusses its relation to science and scientific ontology. Chapter 3 presents two important legal questions about causation and the entities those questions are about. Chapter 4 provides a characterization of the entities that much of the scientific knowledge that can be used to answer these questions is about. Chapter 5 contains a comparison of these legally and scientifically relevant entities and a characterization of some relevant differences between them. Chapter 6 describes some epistemic gaps to which these differences give rise when legal questions are answered via scientific knowledge. (The term "epistemic gaps" refers to gaps in

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[62] Gärdenfors et al. *Evidentiary Value*, 1983. See also Stening, *Bevisvärde,* 1975.

[63] Sahlin and Persson, "Epistemic Risk", 1994. See also Sahlin, "On Epistemic Risk and Outcome Risk in Criminal Cases", 1989, for a discussion about the relation between epistemic risks and the Evidentiary Value Model.

[64] Persson, *Risker i kunskapens mellanrum*, 2007, pp. 67 ff.

our knowledge; it must not be confused with "epistemological differences", which refers to differences between legal and scientific standards of proof.[65]) Chapter 7 discusses the prospect of adapting legal ontology in the light of these gaps. Chapter 8 contains a summary of the thesis.

[65] Section 1.2.1 above.

2 Legal Ontology and Science

2.1 Introduction

This chapter discusses the nature of the legal ontology and its relation to science and scientific ontology. Section 2.2 distinguishes two kinds of ontological difference that are of particular relevance to the present investigation. Section 2.3 argues that law has a distinct ontology which is relative to legally relevant considerations. Section 2.4 deals with the relation between legal and scientific ontology and argues that the legal ontology should be given priority in legal contexts. In Section 2.5 some ways in which science and other disciplines nevertheless remain relevant to the legal ontology are discussed. Section 2.6 contains a summary of the most important conclusions of the chapter.

2.2. Kinds and Individuals

In this monograph I am interested in the ways in which ontological differences between law and science obstruct efforts to answer legal questions by applying scientific information. As explained in the previous chapter, I am interested in difficulties that arise as the result of differences in the way the world is *categorized* within distinct

theoretical frameworks.[66] Two kinds of difference in categorization are of particular interest here. The first is a difference with respect to the *kinds* that are recognized within distinct theoretical frameworks.[67] For example, Swedish citizens constitute a relevant kind in some theoretical frameworks, but not in others. Such a difference in kind does not in itself imply that the individuals that qualify as Swedish citizens in the former are unrecognized in the latter – where they may instead be recognized as instances of other kinds, such as females, males, Caucasians, and so on. The second difference, however, is a difference between the *individuals* (also referred to below, where appropriate, as "particulars" or "instances") that are recognized within distinct frameworks.[68] For example, particular human beings and particular pieces of land are recognized as relevant individual entities in some theoretical frameworks, but they are irrelevant in others, where it may instead be their chemical components that are of interest. In addition to differences with respect to the kinds and individuals that are recognized, it is theoretically possible for two frameworks to make use of exactly the same categorizations, but simply to label them differently. I suspect, however, that terminological differences of this kind are relatively rare, at least among systems that use the same national language. If an individual is labelled differently in two theoretical frameworks, this difference will often, presumably, reflect an underlying difference in categorization.

In this and the following chapters I will argue that law and science differ with respect both to many of the kinds and many of

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[66] Section 1.2.2.

[67] In Hempel's words, a "classificatory concept represents […] a characteristic which any object in the domain under consideration must either have or lack; if its meaning is precise, it divides the domain into two classes, separated by a sharp boundary line" (*Fundamentals of Concept Formation in Empirical Science*, 1952, p. 54).

[68] Thus in addition to the boundary line between classes referred to by Hempel (see previous note), a categorization may also involve particular boundary lines "around" the individual members of the classes that it recognizes.

the individuals that they recognize. These differences are inevitably associated with some terminological differences, but it is the underlying differences in kinds and/or individuals which are of primary interest in the present enquiry. Purely terminological differences are of less importance here, but – if they exist – much of what will be said in this chapter will have bearing on such differences too.

2.3 A Distinct Legal Ontology

The legal ontology is reflected in the legal rules. Consider, for example, chap. 32 sec. 1 of the Environmental Code, which states that "Compensation […] shall be payable for bodily injury, material damage and pecuniary loss caused by an activity pursued on a property […] Compensation for damage that is not caused deliberately or through negligence shall only be payable where the disturbance that causes the damage is unacceptable in view of local conditions or to the extent that such disturbance normally occurs in similar conditions". This section makes use of notions such as "bodily injury", "material damage", "property", "cause" and "negligence". Consequently, it refers to, and presupposes the existence of, types of entity such as bodily injury, material damage, negligence, and so on. The entities designated in this section are all legally relevant entities. Thus, roughly speaking, bodily injury and material damage are regarded as legally relevant because they are undesirable, (at least partly) compensable, and affect human interests. Negligence is regarded as legally relevant because it is considered an undesirable feature of some human behaviour. Like the requirement of causation, the requirement of negligence serves to limit (and justify) the legal liability for bodily injury and material damage which the section imposes.

When legal rules like chap. 32 sec. 1, Environmental Code, are applied in particular cases the question arises whether the entities referred to by the rule exist in the manner the rule requires if a particular legal consequence is to be triggered. Thus the application

of a legal rule will give rise to questions such as: Did the defendant's negligence cause the plaintiff's injury? The answers to such questions will depend on both the circumstances of the actual case and what the legally relevant entities are – e.g. on what the law means by causation and negligence. The answering of such concrete questions, in which the legally relevant entities are located in actual courses of events, will often give rise to further specifications of the legally relevant entities. Thus it has been argued that application of the criterion of negligence in Swedish law reveals three alternative criteria: abnormal behaviour, economically inefficient behaviour, and behaviour creating insecurity.[69] If this is correct, and if the differences between these criteria are legally relevant,[70] it can be argued that negligence is actually not one but three kinds of legal entity.[71]

Chap. 32 sec. 1, Environmental Code, (and other statutes) makes use of words which also are used in ordinary language. It is often said that, as a rule, the words of legal statutes are to be interpreted in accordance with their meaning in ordinary language unless there are good reasons to do otherwise.[72] This gives the impression that the legal entities coincide (as a rule) with the entities to which this ordinary language refers. In order to appreciate the uniqueness of the legal ontology, it is important to see that this conclusion is mistaken. To begin with, the rule that the words of legal statutes are to be interpreted in accordance with ordinary language has clear exceptions. For example, it is generally acknowledged that an established legal meaning of a word has priority over divergent non-legal meanings. Good examples of established legal meaning can be

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[69] Dahlman, *Konkurrerande culpakriterier*, 2000, pp. 33 ff.
[70] See Lindahl, "Operative and Justificatory Grounds in Legal Argumentation", 2003, pp. 197 f.
[71] Possibly even more: cf. the discussion referred to in section 3.3.1 of the way the legislation's focus on environmental protection may have affected the legal notion(s) of negligence.
[72] See, for example, McCormick and Summers, "Interpretation and Justification", 1991, p. 512.

found in situations in which there is an explicit legal definition of a word used in a legal context. Consider, for example, the Swedish word "bil" which is similar to the English "car". In Section 2 of the (Swedish) Act on Road Traffic Definitions (SFS 2001:559) this term is legally defined as a "motor vehicle furnished with three or four wheels or runners or belts which is not regarded as a motorcycle or a moped". Vehicles conforming to this definition are then "... grouped into family cars, lorries or buses." This legal meaning of the word "bil" is presumably different from its meaning in ordinary Swedish (and English) language, which, I assume, does not apply to vehicles on runners. When an established legal meaning of this sort exists, arguments in favour of an alternative interpretation according with ordinary language will normally not be successful.

The contrasting legal and non-legal meanings of the word "bil" reflect the different functions which this word serves in legal and non-legal contexts. The Act on Road Traffic Definitions provides definitions to be applied in several statutes. The government bill of this act motivates the general definition by referring to the fundamental importance of the notion in delimitation of the rights and duties the associated statutes imply.[73] The reason for extending the term "bil" to cover motor vehicles on runners is therefore, presumably, that the question of whether a vehicle is furnished with wheels or runners is immaterial to the delimitation of rights and duties in these statutes. In a non-legal context, on the other hand, and perhaps in other legal contexts too, it is useful to distinguish between vehicles on wheels and vehicles on runners. This difference in meaning also reflects a difference in underlying ontology: the word "bil", in the Act on Road Traffic Definitions, refers to a distinctively legal category.

The interpretation of words in a legal context in a way that conflicts with their meanings in ordinary speech does not, however,

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[73] Govt. Bill 2000/01:95 p. 93. (Preparatory works are regarded as important sources of law in Sweden.)

presuppose that explicit legal definitions exist.[74] This can clearly be seen when the reasons *for* interpreting these words in accordance with ordinary language are considered. A Swedish criminal case, NJA 1985, p. 788, and the discussion which followed it, illustrates the mechanisms at work here. In this case, the now abolished Act on the prohibition of professional boxing (SFS 1969:612) was of primary importance.[75] Its first section stated: "Anyone who in this state participates in a competition, exhibition or training match in professional boxing shall be sentenced either to a fine or imprisonment for at most two years". The Swedish professional boxer Anders "Lillen" Eklund was accused of participation in several training matches. However, within the boxing community, it is usual to distinguish between sparring sessions and training matches. Once this distinction was recognized, it became clear that the activities in which Eklund had participated did not constitute training matches but were merely sparring sessions. The question therefore arose whether sparring was to be regarded as an activity covered by the term "training match" in a legal sense.

The Swedish Supreme Court found that the Swedish prohibition of professional boxing was a response to the risk of medical damages associated with it, and that this risk, according to the preparatory

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[74] Part of the point made in the rest of this section is similar to one made by Bo Wennström, who has analyzed legal language on the basis of a Wittgensteinian theory of "meaning as use" (Wennström, *The Lawyer and Language*, 1996, p. 17). According to Wennström "[t]here are a great many features in a real linguistic situation that differentiate an 'everyday use' from a 'legal use'" (*ibid*, p. 119), and it is "not the case that it is 'everyday language' that is used in our laws just because they make use of the 'same words' as ordinary language" (*ibid*, p. 76). My interest, however, is in ontology rather than language, and I have not assumed a particular theory of meaning. Instead I am interested in the ways in which the legal *categorizations* that underlie legal notions depend on legally relevant considerations which differ from the considerations that are relevant in non-legal contexts.

[75] Professional boxing is no longer forbidden in Sweden but requires permission (sec. 1, Act on Requirement of Permission for Certain Matches of Martial Art, SFS 2006:1006).

works, exists also in sparring sessions. There was no support for the assumption that usage of the words "training match" in the law's first section was intended to limit the prohibition to punching practice under the more competitive circumstances implied by the boxing community's understanding of "training match". According to the court, the statements in the preparatory work were unambiguous: the distinction between sparring sessions and training matches made within the boxing community should not be granted any relevance vis-à-vis the meaning of the words of the act.[76]

Of particular interest here is the criticism this decision has attracted. Critics have argued that the Supreme Court's decision conflicts with the Principle of Legality *nullum crimen*, *nulla poena sine lege*.[77] According to this principle, there can be no crime, nor can punishment be dispensed, unless in relation to existing law. The court's generous interpretation of the words "training match" was said to "stretch the Principle of Legality to its breaking point".[78] One critic stressed that the principle requires clarity and implies that "citizens must be able to determine what is and what is not a punishable offence".[79] Our ability to do this is clearly threatened if the legal interpretation of words departs from the meaning the same words have in the context to which the law is being applied. It should be observed that in this case, the relevant context and interpretation was that of the boxing community to which the regulation applied. In the application of much other regulation, the arguments just mentioned would instead favour interpretations mirroring ordinary language.

The court's reasoning and the criticism that followed illustrate a tension between interpretation based on the purposes of a law, as these purposes are expressed in preparatory works, and interpretation guided by non-legal language. Conflict like this is

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[76] NJA 1985 p. 788, at 795.
[77] Lambertz, "Träningsmatch i Högsta domstolen", 1986, p. 227, Wennström, *The Lawyer and Language*, 1996, pp. 48 f.
[78] Lambertz, "Träningsmatch i Högsta domstolen", 1986, p. 228.
[79] Wennström, *The lawyer and language*, 1996, p. 49.

often discussed in terms of different *methods* of interpretation – e.g. literal as opposed to teleological method.[80] However, the term "method", as it is used here, is potentially misleading. First, talk about the literal method of interpretation, and the statement that legal statutes shall *as a rule* be interpreted in accordance with ordinary language, obscures what is really going on. This terminology gives the in my view false impression that it is the meaning of ordinary language that is of primary legal relevance. The mechanisms behind the legal interest in ordinary language appear clearly in the discussion that followed the boxing case. As we have seen, the Principle of Legality was used to argue that the words "training match" should be given a meaning that is in keeping with their use in a certain non-legal context. The Principle of Legality is intimately connected with the Rule of Law, which requires the law to be predictable by those to whom it applies. These are thus very fundamental legal considerations. Legal interpretation in accordance with ordinary language will often promote predictability, but this does not mean that it is ordinary language as such which is legally relevant. Rather, it is the underlying predictability that matters.[81] This can also be seen clearly in the boxing case, where what was at stake was not the ordinary meaning of the words "training match", but their meaning within the boxing community to which the defendant belonged.

Furthermore, the Supreme Court's ruling in this case, whether one agrees with it or not, illustrates the possibility that other legal concerns, such as those relating to the purpose of the law as it is

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[80] See, for example, Peczenik, *Vad är rätt?*, 1995, pp. 330 ff. and p. 363 and Ekelöf and Edelstam, *Rättegång 1*, 2002, pp. 79 ff.

[81] In my opinion, this characterization of the legal role of ordinary language is an adequate part of a complete picture of the theory-relativity of legal ontology. Those who hold that ordinary language has a more significant legal role than the one assumed here can instead accept the conclusion that legal and scientific ontology differ by, for example, accepting that ordinary language can be used to describe a distinct legal ontology and/or that scientific ontology differ from non-scientific, including legal, ontology.

regarded in preparatory works, may outweigh the need for predictability – and that this is also the case in criminal law. Presumably most, if not all, of the words used in legal norms to refer to legally relevant entities can be interpreted in ways that conflict with their colloquial meaning. Outside the context of criminal law, where the need for predictability is less fundamental, allowance for interpretations diverging from ordinary language is even greater. Ordinary language is thus at most an imperfect guide to legal ontology.

More generally, legal rules refer to entities whose importance depends on a complex of legally relevant considerations – considerations relating to morality, economic factors, causal potential, legal efficiency, predictability, and so on. The considerations that underlie a particular legal rule will normally differ from those that are relevant in non-legal contexts, where the purpose and function of the law does not play as salient a role. The interpretation of the linguistic representations of these categorizations is only one of several factors that are legally relevant in this respect. Categorizations that underlie ordinary language or other theoretical frameworks, then, will at most affect and overlap, but not coincide with the legal categorizations. Because legally relevant considerations are effective at the type level as well as at the token level, the legal ontology can reasonably be expected to differ from non legal ontologies with respect to both the kinds and many of the individuals that it recognizes. In this way, legally relevant considerations give rise to a distinct and uniquely legal categorization of the world.

2.4 Legal and Scientific Ontology

Because the considerations that shape the legal ontology typically differ from those that are relevant in a scientific context, the legal and scientific ontology can be expected to differ, too. Consider, as an example, the legally relevant entity "negligent behaviour". The class of negligent behaviour includes the careless discharge of wastewater,

use of biocides without adequate preventive measures, medical maltreatments, and so on. These behaviours will – together, but sometimes also individually – instantiate a number of distinct scientific kinds of entity, such as chemicals, viruses and bacteria. From a legal perspective, however, the behaviours that instantiate them are sufficiently homogeneous in the light of legally relevant considerations to make them all qualify as instances of the kind *negligent behaviour*. The legal relevance of negligent behaviour is therefore an example of the way in which the law both operates with other classifications than those in science and recognizes other individuals. Like many other legally relevant kinds,[82] negligent behaviour involves a practically endless disjunction of conjunctions of instances of distinct scientific kinds.

A similar phenomenon, often referred to as "multiple realizability", occurs between many scientific categorizations as well. An example that will be very familiar to philosophers of mind is this: mental states of the same psychological kind (e.g. a particular kind of depressive state) can be expected to instantiate a number of brain states belonging to distinct neurological kinds.[83] The fact that many scientific categorizations differ in this respect is often explained by reference to the observation that each representation is necessarily partial and involves a particular perspective of the world.[84] Whereas, for example, the categories of physics are relative to an interest in physical properties, the categories of biology are relative to biology's interest in the living. This explanation also applies – at least, in part – to the differences between legal and scientific categorizations. For example, part of the explanation as to why legal categories often involve instances of a large number of distinct scientific kinds is that disciplinary divisions, which underlie scientific categorizations, normally lack relevance to the legal categorizations. Furthermore, it

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[82] See the discussion in Chapters 3-5 for further examples.

[83] See, for example, the discussion in Fodor, "Special Sciences", 1974.

[84] See, for example, Ashby, *An Introduction to Cybernetics*, 1957 (1956), p. 107, Mitchell, *Unsimple Truths*, 2009, p. 31, Munn, "Introduction", 2008, pp. 11 f and Searle, *The Construction of Social Reality*, 1996 (1995), p. 176.

is characteristic of the law that it works by affecting human behaviour and serves human interests.[85] Human behaviour is therefore, insofar as it is relevant to legal responsibility, a feature of the world that is legally salient; accordingly, this salience is reflected in many legally relevant categories. As was shown in the previous section, the legal categorization of the world is also relative to factors of relevance to the interpretation of the linguistic *representations* of these categorizations. These include factors pertaining to the representations themselves, such as their meaning in ordinary language. Such factors, too, will therefore affect the way in which these representations are interpreted in particular cases, and hence help to determine the content of the legal ontology.

The categorizations that are relevant within different theoretical frameworks mirror the parts of the world that are of interest relative to each framework. Roughly speaking, it is the aim of the law to promote justice and the aim of science to explain phenomena. At bottom, the difference between legal and scientific ontologies reflects differences between *what* in the world is relevant to these different objectives. From this it follows rather straightforwardly that when legal and scientific ontology differ *the legal ontology should be given priority in a legal context*. Thus, because differences between the legal and scientific ontologies reflect differences between what in the world is relevant to legal and scientific objectives, the legal ontology should be applied in contexts where the application relates to legal objectives. As will be explained in the next section, this does not mean that science and scientific ontology are legally irrelevant. It does mean, however, that in a legal context it is questions about the entities that are demarcated by legally relevant categorizations that ultimately are to be answered.

This ordering of legal and scientific ontology is perhaps obvious, but ontological differences have nevertheless given rise to controversies over which ontology ought to prevail in a legal context. The Swedish case NJA 1969 p. 311 provides a nice

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[85] Cf. Chapter 3.

illustration of the problems at issue. In this case the plaintiff, A, was hit by a car driven by the defendant, B. A sustained a skull injury in the accident and it was indisputable that B alone caused it. After the accident A suffered from complaints such as severe headaches, double vision and loss of memory, and became disabled. The legal question was whether the accident had caused the disability. Several medical experts testified that the disability had not been entirely caused by the injury sustained in the accident. Rather, they speculated, some other injury must have existed before the accident, perhaps dating back to the years A had spent in concentration camps during the Second World War. Nevertheless, the Supreme Court awarded full compensation. The legal reasoning was, in brief, that irrespective of the existence of an earlier injury, the injury contracted in the accident contributed to, and triggered, the subsequent disability.

The case was followed by vigorous interdisciplinary debate. Some medical experts criticized the Supreme Court's judgment, complaining that the disability in the case was caused mainly by the existing injury, not the injury to A in the accident.[86] The experts' judgment can perhaps be explained by the medical observation that the establishment of causal relations between a condition and external factors generally has a negative effect on the patient's rehabilitation process (by affecting his willingness to take active part in the process).[87] Because rehabilitation was an essential part of the experts' normal brief, this seems to have made them reluctant to recognize merely triggering factors as causes. However, in the Swedish legal context, where the boundaries of legal liability were at

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[86] An overview is given in Wahlquist, "Lätta skallskador med långvariga besvär – några rättsliga aspekter", 1973, pp. 4410 ff.

[87] See, for example, Silfverskiöld, "Ersättning vid långvariga besvär efter lätt skalltrauma", 1973. See also Claes-Göran Westrin's statement about the dynamic relation between diagnosis and prognosis in "Medicin och juridik hand i hand i praktisk rättstillämpning", 1982, p. 156.

stake, causation was (and is)[88] generally regarded as a *qualitative* matter which is independent of the *degree* of causal contribution.[89] Here, therefore, we appear to have a potential difference between causation as a legal category and as understood by the medical experts in this debate.

Causation in the law has been the subject of a very great deal of jurisprudential discussion. Although much controversy remains, these discussions have all, to an extent, taken legally relevant considerations as their starting point. The Supreme Court's understanding of causation in NJA 1969 p. 311, unlike that subsequently adopted by the medical experts, was in keeping with the legal view prevalent in Sweden at the time.[90] Legal considerations pertaining to the conditions in the case do not – at least, at first sight – motivate a departure from this understanding. If the Supreme Court's understanding of causation is legally preferable to that of the medical experts, the former should be given priority in a legal context.[91]

It should be noted that, even if it is acknowledged that causal judgments are affected by the context in which they are made, it may be too hasty to conclude that the very meaning of "causation" depends on the context. It has been argued that this kind of difference in opinion can be explained by the fact that lawyers and scientists ask for different causes – not by the supposition that they mean different things by "causation".[92] For example, it has been

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[88] See, for example, Schultz, *Kausalitet*, 2007, and the discussion in Chapter 3 below.

[89] Wahlquist, "Lätta skallskador med långvariga besvär – några rättsliga aspekter", 1973, pp. 4411 f., and Peczenik, *Causes and Damages*, 1979, p. 269.

[90] At least, if one of the court's findings is reinterpreted so as to make it coherent with the rest of the court's reasoning (see Peczenik *Causes and Damages*, 1979, p. 269).

[91] See also Schultz, *Kausalitet*, 2007, p. 398.

[92] See, for example, Sintonen, "Causation and the Legal Point of View", 1983, Honoré, "Principles and Values Underlying the Concept of

suggested that, at least sometimes, only factors with which the doctor "can deal in diagnosing, in curing, or in seeking to forestall" count as causes in a medical context.[93] On this view, the medical experts' and lawyers' understanding of causation *as such* in NJA 1969 p. 311 would be the same; the difference would instead be that the former ask for, say, curable causes or major causes, while the latter ask for causes that are relevant from the legal point of view.[94] Alternatively, the reason for the medical expert's reluctance to regard the relation at issue as causal can be explained by reference to considerations reminding us of those that in a legal context are relevant to the notion of *adequate* causation.[95] Just as many have argued that questions of adequacy should be kept from questions of causation in a legal context,[96] it could be argued, perhaps, that a similar distinction is appropriate in a medical context in the light of medically relevant considerations.

In a deeper philosophical analysis, then, it may turn out that the notion of causation being applied is one and the same regardless of whether the considerations in play are medical or legal. Proper investigation of this issue falls beyond the scope of this

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Causation in Law", 2002, p. 3, and Engelhardt, "Relevant Causes", 1981, p. 126.

[93] Malone, "Ruminations on Cause-in-Fact", 1956, pp. 63 f.

[94] It is worth noting that this unifying view also resolves the disagreement in the case in favour of the lawyers. If the experts are called in to answer the legal question, and if they instead answer another, medical, question, it is clearly the experts, not the lawyers who are mistaken.

[95] The legal notion of "adequate causation" can, somewhat simplistically, be described as the sub-class of the causal relations which ground legal responsibility. (See Section 3.3.3 below for more comprehensive discussion.) It can be noted that Sintonen explains the difference in NJA 1969 p. 311 by referring to the legal "principle that a tortfeasor is liable for the harm that has resulted from *a cumulation of his act and the victim's illness or vulnerability*" (Sintonen, "Causation and the Legal Point of View", 1983, p. 271). It seems to me that a more appropriate explanation is that the medical experts in this case seem to have adopted a converse principle.

[96] See Section 3.3.3.

monograph.[97] However, the example illustrates that specific differences between the status that an entity is accorded in a legal context and the status it is accorded – perhaps erroneously – in a scientific one may become problematic when legal questions are answered through the application of scientific information. The principle that legal ontology should be given priority is as important to such possibly superficial differences as it is to ontological differences of a more fundamental character.

2.5 The Relevance of Non-Legal Disciplines to Legal Ontology

The conclusion that legal ontology should be given priority over scientific ontology in a legal context will perhaps strike some readers as dangerous and chauvinistic. It is therefore important to make it clear that the priority of the legal ontology does not excuse legal arbitrariness; nor does it imply that science and scientific findings are irrelevant in a legal context.

To begin with, it should be stressed that the priority of the legal ontology does not imply that the categorization adopted by a judge or a court in a particular case is the best one in the light of considerations of legal relevance. The American case Babbitt v. Sweet Home exemplifies what is at stake here. An important question in this case was how to interpret the word "take" in the Endangered Species Act (16 U.S.C. 1531 et seq., 1973), according to which it is unlawful for any person to take endangered or threatened species. The Supreme Court found that the word "take" in the act includes some habitat modifications, a finding that ought generally to favour species protection. However, in a concurring opinion, Justice O'Connor held that "the regulation is limited by its terms to

[97] See Section 1.2.3 and Section 4.4.3.

actions that actually kill or injure individual animals".[98] This limitation has rightly been criticized for being too restrictive and to exclude detrimental actions plausibly covered by the act.[99] The categorization assumed by Justice O'Connor in this case is not necessarily, therefore, the one most favoured by legally relevant considerations. More generally, the categorization adopted by a particular judge or some other legal actor is *not automatically* more appropriate, given considerations of legal relevance, than a categorization advocated by, say, a scientific expert. (It is another matter that a legally trained person is normally better placed to judge what the legally relevant considerations consist in.)

It should also be obvious that scientific knowledge may well provide information that is relevant to the determination of the most appropriate categorization in a given legal context. Thus, ecological knowledge may provide information on how well different interpretations of the word "take" in the Endangered Species Act will contribute to the protection of endangered species.[100] Scientific findings about the workings of the world, including the complexity and interdependence of nature, may thus provide information about factors promoting efficient regulation.[101] This does not mean that the content of the law can be based on such ecological knowledge alone. Other legally relevant considerations – relating to *inter alia* predictability, morality and economic issues – must also be taken into account when the context is legal.

Similarly, the scientific information that underlies scientific categorization can help to establish what "entity-boundaries" are legally appropriate. For example, in NJA 1969 p. 311, the understanding of causation presupposed by many of the medical experts seems to have been informed by knowledge of the negative impacts that liberal recognition of causation between injury and

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[98] *Babbitt v. Sweet Home* (1995) at 2419.
[99] Brooks, *Law and Ecology*, 2002, p. 294.
[100] Brooks, *Law and Ecology*, 2002, p. 294.
[101] Cf. Brooks, *Law and Ecology*, 2002, pp. 366 ff.

damage will have for the patient's recovery.[102] This knowledge can certainly be relevant to legal entity-boundaries, too. Nevertheless, whether it is, under what conditions, and in what way it should affect legal entity-boundaries (e.g. by affecting the legal notion of causation, adequacy or something else)[103] is a legal question to be settled in the light of all considerations that are relevant in the actual legal context.[104] Even if some of the considerations underlying legal and scientific categorizations coincide, the categorization that is best in the light of *all* legally relevant considerations may very well differ from the scientific categorization.

Moreover, legal adoption of an originally non-legal understanding of a notion such as that of causation may very well be justifiable. Thus causation is often regarded as an important condition of moral responsibility, and it has been argued that the legal requirement of causation is motivated by considerations linked to the concept of justice.[105] To the extent that morality is relevant in this respect, it is reasonable to let considerations of relevance to moral responsibility affect the conception of causation deployed in law. Thus, some observers believe that the world contains a relation which, in an objective sense, constitutes causation, and that this relation is what matters for moral, and hence legal, responsibility. According to Michael Moore:[106]

> It is morality, not legal policy, that tells us that actions that cause harm are more blameworthy than those that merely attempt or risk such harm. It is metaphysics, not legal policy, that tells us when an action *causes* a certain harm. […] A legal doctrine of intervening causation is justified […] if it corresponds to a pre-legal, metaphysical notion of intervening causation.

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[102] See the discussion in Section 2.4.
[103] See Schultz, *Kausalitet*, 2007, p. 41 and p. 222.
[104] Cf. Wahlquist, "Lätta skallskador med långvariga besvär – några rättsliga aspekter", 1973, p. 4411.
[105] Schultz, *Kausalitet*, 2007, pp. 389 f.
[106] Moore, "The Metaphysics of Causal Intervention", 2002, p. 828.

If this view is accepted, an interpretation of causation within a discipline like philosophy (which includes the search for a metaphysical notion of causation) can indeed be relevant to the legal requirement of causation. However, it is important to appreciate that even if such a notion of causation is adopted within the law, the very adoption of it is a normative matter. More importantly, the legal considerations that make this originally philosophical notion of causation legally relevant have to share space with other legal considerations which in their turn can motivate departure from this notion. Thus, the legal notion of causation – which, on this view, is a function of considerations relating to the legal relevance of a metaphysical notion – is also a function of other considerations of legal relevance. Consequently, even if a metaphysical notion of causation seems appropriate in the light of some legal consideration, it is not self-evident that it will be in full conformity with the notion which emerges from the process in which both this and other considerations of legal relevance are taken into account.[107]

The principle that the legal ontology should be given priority therefore does not mean that science and scientific information lack importance to the legal categorizations. Nevertheless, it will have some rather far-reaching and perhaps surprising consequences with respect to science's legal relevance. Consider, as an example, the many originally scientific notions ("chemicals", "gene sequences", "species", "biodiversity", and so on) that have entered the legal system. It is often said – as an exception to the rule that words in a legal rule should be interpreted in line with ordinary language – that words with an established technical meaning should be interpreted so as to retain that meaning.[108] This seems to imply that words used to refer to scientifically relevant entities ought to be given the same meaning in law as they are in science and thus refer to the same entities when they occur in the legal system.

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[107] Cf. the discussion of the choice between the but-for test and the NESS test in Section 7.4.3.

[108] MacCormick and Summers, "Interpretation and Justification", 1991, p. 513.

However, originally scientific notions are adopted by the legal system because of their supposed importance for legal purposes. Through the adoption, they are assigned a role in the legal system which is intended to serve these legal purposes. It can therefore be questioned whether these legal-scientific notions should be taken to refer to the same kinds of entity as they do in a scientific context. "Biological diversity" is one example of an originally scientific notion that has been imported into legal regulation. Chap. 1 sec. 1, Environmental Code, declares that the purpose of the Environmental Code "is to promote a sustainable development which will assure a healthy and sound environment for present and future generations". Later in the same section it is stated that the Code shall be applied in such a way as to ensure, *inter alia*, that "human health and the environment are protected against damage and detriment …" and so that "biological diversity is preserved". According to the government bill the reference to the preservation of biological diversity is intended to illustrate the way in which the need to protect human health and the environment, stated earlier, can be met. Biological diversity, the bill says, is "of immediate importance to the environment and, consequently, to human health".[109] These elaborations suggest that the use of the notion "biological diversity" in law is motivated by the assumption that decreases in diversity will have a negative effect on the environment and human health. Biodiversity is legally relevant, then, because it affects legally recognized interests associated with human health and the environment.

In science biodiversity is often regarded as interesting in virtue of its importance to the functioning of an ecosystem.[110] The legal reasons for recognizing biodiversity adumbrated above are clearly related to this importance. However, the notion of biodiversity is

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[109] Govt. Bill 1997/98: 45, Part 1, p. 214; cf. Part 2, pp. 7 f.

[110] Sugihara, "Diversity as a Concept and its Measurement", 1982, pp. 564-565. (Cf. Wardle et al., "Biodiversity and Ecosystem Function", 2000, and the discussion of diversity's relevance to stability in Shrader-Frechette and McCoy, *Method in Ecology*, 1993, pp. 4 ff).

indeterminate[111] and its definition has been said to vary with the need of the researcher.[112] If "biological diversity" has several different meanings, questions about which of these meanings to adopt in a legal context arise. The way "biological diversity" is understood in law should, as far as possible, accord with the reasons for its employment in a legal context. Following the statement in the government bill, then, it should refer to an entity which is important in the protection of human health and the environment. If the effects of distinct scientific understandings of "biological diversity" differ in this respect, it therefore seems reasonable to allow considerations of legal relevance to govern the choice between these understandings in a legal context. Once this is allowed, however, a particular legal understanding of biological diversity can hardly be rejected if it accords better with these legally relevant considerations than any of the scientific understandings do. This does not mean that scientific information is irrelevant to the legal understanding of originally scientific entities. For example, scientific information would be relevant to the extent that it provides information about the relationship between different understandings of "biological diversity" and the protection of legal interests. Even so, it is a legal matter to determine if and when scientific information and scientific considerations are legally relevant, and decisions about the effect of this on the legal ontology should be made in the light of all legally relevant considerations.

It should also be acknowledged that sometimes there will be legal reasons for retaining a term's original scientific meaning – e.g. where an understanding in accordance with a term's original scientific meaning will facilitate interdisciplinary communication, which can be a factor of legal relevance and is also likely to promote predictability. If considerations in favour of retaining a term's original meaning outweigh those against it, the outcome of legally

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[111] Regan et al. "A Taxonomy and Treatment of Uncertainty for Ecology and Conservation Biology", 2002, p. 624.

[112] Ricotta, "Through the Jungle of Biological Diversity", 2005, p. 30. See also Shrader-Frechette and McCoy, *Method in Ecology*, 1993, pp. 26 ff.

and scientifically relevant considerations will coincide. Even so, these considerations normally differ. There is thus no generally compelling reason why legal entities imported from science should accord with their scientific origins, and where scientific and legal considerations point the same way, the coincidence is a contingent matter. Hence, there is no reason to assume that the adequate outcomes of scientifically and legally relevant considerations will in general coincide. Rather, the differences between the underlying considerations give reason to assume that a legally appropriate understanding of an originally scientific term will, as a rule, differ from its original scientific understanding.

In my opinion, what has been said above applies to all originally scientific entities adopted by the legal system. Against such a generalization some will, perhaps, object that many scientific categorizations are less indeterminate and appear less observer-relative than the notion of "biological diversity". Hence, it may be said, the reasons for avoiding the adoption of a divergent legal understanding are stronger in these cases. In response to this hypothetical counter-argument, I would say, first, that biological diversity is presumably representative of many scientific entities of legal interest. From the point of view of environmental law, for example, ecological knowledge is important; but, in contrast with sciences like physics and chemistry, ecology is to a large extent concerned with heterogeneous macro-level objects.[113] Such objects do not conveniently arrange themselves, unambiguously, into categories; their proper classification is often a matter of debate. The notion of a *species* is another example of an originally scientific entity, adopted by the law, which lacks clear scientific content.[114] Furthermore, it can be asked whether any of the entities with which science is concerned today can be characterized as theory-independent.

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[113] See Section 4.3.

[114] See, for example, the discussion in Dupré, *The Disorder of Things*, 1993, pp. 37 ff.; also Brooks et al., *Law and Ecology*, 2002, p. 337, for a discussion of the legal relevance of this ambiguity.

More importantly, however, even if we grant that some of the entities with which science is concerned are theory-independent natural kinds, it does not follow that the law is confined to the natural boundaries studied by science. Legal ontology marks what, in the world, is of interest given the aims and functions of the law. Although we may debate what precisely those aims and functions consist in, they are certainly not to describe the fundamental structure of the world. Thus, some instances, or combinations of instances, of a natural kind may be legally relevant even if all of them are not. Indeed the Environmental Code already seems to adopt a more narrow conception of *chemical substances* than science does. The Code defines "chemical product" as a chemical substance or a preparation of chemical substances.[115] According to the Government bill, this understanding of chemical products includes all chemical substances and all preparations of chemical substances that are *subject to human handling*.[116] This understanding of chemical substances appears harmless and is rather natural given that the Code is designed to regulate human behaviour. It is nevertheless rather striking, as chemical kinds are often treated as paradigmatic examples of natural kinds.

Although some scientific categories may be relevant and adopted as part of the legal ontology, it is thus important to remember that this is done, where it is, because the scientific categories have legal relevance, too. It is also important to see that the scientific categories that are adopted by the law thereby, by definition, become legal categories. In their capacity as legal categories they are relative to underlying legal considerations including, but not excluded by, the considerations which made the scientific category legally relevant in the first place. When they are exposed to other legal considerations, the originally scientific

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[115] Chap. 14 sec. 2, Environmental Code.

[116] Govt. Bill 1997/98: 45, Part 1, p. 168. The code also distinguishes between chemical products and products containing or treated by chemical products (prop 1997/98: 45, part 1 p. 167 and chap. 14, sec. 1, par. 2, Environmental Code.)

boundaries around the now legal categories may change; the categories may eventually deviate from their scientific origins.

The principle that the legal ontology should be given priority in a legal context does allow science to influence legal ontology, then – as long as such influence is appropriate in the light of legally relevant considerations. In the rest of this monograph, I will discuss a special kind of influence that science may have on legal ontology. More precisely, I will show how differences between scientific ontology and some presently employed legal categories make it difficult to establish legally relevant states of affairs. These differences will systematically limit the impact of legal rules whose consequences require that these states of affairs are established. As will be discussed at greater length below,[117] this observation is in itself a legally relevant consideration: it should be allowed to influence the legal ontology. It does not imply, however, that the best way to ensure such influence is to subordinate the legal ontology to the scientific ontology.

2.6 Conclusions

In this chapter I have argued that the law has a distinct ontology which is relative to legally relevant considerations. Because these considerations differ from those that are relevant in a scientific context, legal and scientific ontology can be expected to differ with respect to both the kinds and the individuals that they recognize. I have also argued that when legal and scientific ontology differ, the legal ontology should be given priority if the context is legal. Scientific findings – including scientific ontology – can nevertheless be of relevance in the light of legally relevant considerations. Even so, there is no reason to assume that scientific categorizations will generally be most appropriate, legally speaking.

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[117] See Section 7.2.

3 Legal Questions about Causation

3.1 Introduction

In this chapter I present a characterization of two legal questions about causation. Section 3.2 presents the two questions together with an important aim of the rules that give rise to them. Section 3.3 provides a general characterization of the causes, effects and causal relations that these questions draw attention to and thereby shows the scope of the underlying aim. Section 3.4 summarizes the most important conclusions of the chapter and formulates two hypotheses for the subsequent enquiry.

3.2 Aims, Rules and Questions about Causation

3.2.1 An Aim of the Law

What one regards as the aim of the law depends on the theory of law one embraces as well as one's moral beliefs and/or political views. The provision of a generally accepted, detailed characterization of the aim of the law is therefore a mission impossible. In this monograph I am interested chiefly in a specific aim of the law: that

of *counteracting detrimental consequences of human behaviour*.[118] The detrimental consequences of primary relevance in the present investigation relate to human health and the environment. Where appropriate, I will hereafter refer to these consequences as "damage".

I do not claim that the counteraction of detrimental consequences of human behaviour exhausts what the law aims to achieve. However, at a very general level it describes an important task of the law, and one that underlies large parts of the regulation. It is, for example, reflected in the now widely recognized legal goal of promoting sustainability. This goal is not only stated in the portal section of the Environmental Code, but can be found already in the Swedish constitution.[119] Also, without precise explication of what a sustainable development consists in, it is clear that its promotion is served – in part – by the counteraction of detrimental consequences of human behaviour. Thus, chap. 1 sec. 1 par. 2, Environmental Code, picks out some elements said to be of particular importance to such a development and thereby provides a more precise indication of the consequences the Code applies to and thus seeks to counteract.[120] More generally, the aim of counteracting detrimental consequences of human behaviour can be said to underlie parts of, for example, penal and tort regulation whose immediate relevance to sustainability is sometimes, perhaps, less obvious. A study of the ways in which ontological differences between law and science impede the achievement of this aim thus promises to be of rather wide-ranging legal relevance.

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[118] I will leave it open whether the aim is that of the legislator, the voters, those who apply the law, or some other agent.

[119] Chap. 1 sec. 2 par. 3, Instrument of Government (KK 1974:152).

[120] Chap. 1 sec. 1 par. 2, Environmental Code states that the Code shall be applied in such a way as to ensure *inter alia* that human health and the environment are protected against damage and detriment, whether caused by pollutants or other impacts, that valuable natural and cultural environments are protected and preserved and that biological diversity is preserved. (Cf. Govt. Bill 1997/98:45, part 2, pp. 7 ff.)

3.2.2 Two Legal Questions about Causation

The legal aim of counteracting detrimental consequences of human behaviour is served by various legal rules which impose different kinds of counteractive responsibility. For example, some rules impose liability to provide economic compensation for, or to otherwise restore damage. These rules work by repairing consequences that have already happened. By deterring behaviour of the same legal kind, they also indirectly prevent detrimental consequences of such behaviour from occurring in the future. Other rules impose obligations to take preventive measures or to refrain from particular behaviour. These rules work by directly preventing some consequences from occurring in the first place.

Rules of these kinds involve causal assessments. The role and nature of these causal assessments will differ from rule to rule. Many causal assessments are made already at the level of legislation. For example, certain *kinds* of behaviour, such as going by car or using a particular biocide, have been generally associated with detrimental consequences in a way that is thought to justify the imposition of counteractive responsibility whenever these kinds are instantiated. As a result, many rules prescribe obligations to take certain preventive measures whenever behaviour of some such kind is undertaken. These rules thus impose a counteractive responsibility on the basis of the risk associated with behaviour of such a kind. The responsibility they prescribe, in a particular case, does not presuppose that undesired consequences would in fact have followed.[121] These general prescriptions, which are based on

[121] Questions about associations between kinds may likewise arise in the *application* of legal rules. One example of a rule which gives rise to such questions is the Substitution Principle in chap. 2 sec. 4, Environmental Code. According to this rule, usage or selling of chemical products or biotechnical organisms that may involve risks to human health and the environment shall be avoided if products or organisms that can be assumed to be less dangerous can be used instead. The question to which this rule gives rise is a question about the relation between a *kind* of product/organism and legally relevant *kinds* of damage. The relation

knowledge of the general associations between legally relevant human behaviour and consequences that the law aims to counteract, are often both economically sound and efficient. Even so, they are imperfect tools with which to achieve the aim that is relevant here. To begin with, they may well prescribe preventive measures that are unnecessarily far-reaching in the particular case. At the same time, however, they may fail to prescribe preventive measures which, while generally unnecessary, are required in the particular situation at hand.[122] Moreover, it is often said that an actual causal relation between the particular behaviour grounding the responsibility and the particular consequence that is to be counteracted is important in the justification of counteractive responsibility.[123]

Consequently, many legal rules also impose counteractive responsibility on the basis of the existence of a causal relation

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between the particular instance of the product/organism (as instantiated in the particular behaviour and the actual circumstances) and possibly ensuing damage in the particular case is irrelevant to this rule.

[122] See, for example, Michanek and Zetterberg, *Den svenska miljörätten*, 2008, p. 55.

[123] See, for example, Moore, "The Metaphysics of Causal Intervention", 2000, p. 828, quoted in Section 2.5 and Schultz, *Kausalitet*, 2007. (Cf. Kutz, *Complicity*, 2000.)The notorious legal scepticism about statistical evidence can also be seen as a reflection of this view. This scepticism is manifested in Cohen's well known paradox of the gatecrasher (*The Probable and the Provable*, 1977, p. 74): 1000 people, including A, are seated on a rodeo but it is known that only 499 of them paid for admission. There is no other evidence. The question at issue is whether A paid the entrance fee or omitted to do so. If the organizers can prove that A omitted to pay the entrance fee they will be entitled to retrieve the same sum from him. If the applicable standard of proof is interpreted as a mathematical probability of 0.501, their claim will succeed on the available evidence. A will thus be obliged to pay them this sum – and so would every other spectator too. According to Cohen, and many others, this would be absurd. For extensive discussion of this issue see also Wright, "Causation, Responsibility, Risk, Probability, Naked Statistics and Proof", 1988, pp 1049 ff., and Brilmayer and Kornhauser, "Review: Quantitative methods and legal decisions", 1978, pp. 145 ff. See also Gärdenfors et al. *Evidentiary Value*, 1983.

between the *particular* human behaviour for which a person[124] can be held responsible and the *particular* damage which is to be counteracted. The appropriate imposition of legal responsibility, according to these rules, will therefore depend on the existence of causal relations between particulars,[125] and the actual imposition of responsibility will depend on the possibility of establishing the existence of such relations. Some of these rules impose a responsibility to counteract damage that has already occurred; others impose responsibility to counteract damage that is yet to occur. Accordingly, the causal questions the application of these rules gives rise to may be either retrospective or prospective. In a rule which, for example, imposes legal responsibility to compensate or otherwise repair damage that has been done, the question is retrospective and runs: "*Did this behaviour cause the damage?*" In a rule which instead imposes legal responsibility to take preventive measures or to refrain from an activity in order to prevent damage from occurring in the first place, the question is instead prospective and runs: "*What damage (if any) will this behaviour cause?*".[126]

These retrospective and prospective questions are thus important, and often used, means of achieving the legal aim of counteracting detrimental consequences of human behaviour. In subsequent chapters I will examine the ways in which differences between legal and scientific ontology hamper attempts to establish the relations that these questions seek through the application of scientific information. For this purpose I shall need to characterize the legal aim of counteracting detrimental consequences of human behaviour and the two questions somewhat more elaborately. I will do this using information provided by some legal rules which serve

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[124] The term "person" is in this monograph used to refer to physical as well as juridical persons. Juridical persons are entities such as the state, joint stock companies and cooperative tenant-owner's building societies.
[125] Or "individuals", see Section. 2.2.
[126] To talk about the "existence" of these relations between particulars, then, is more precisely to say that they have existed or that they will (would) come to exist, unless preventive measures are taken.

as means of achieving this aim and which give rise to retrospective and prospective questions about causation when applied. Therefore, I should first explain how the content of these rules relates to the aim and the questions that I wish to characterize.

3.2.3 Aims and Rules

It should be obvious that legal rules provide some information about the consequences of human behaviour the law aims to counteract. However, the relation between legal rules and legal aims is not straightforward. To begin with, the counteraction of detrimental consequences of human behaviour can hardly be said to exhaust what the law is aimed to achieve. Moreover, the content of legal rules is not merely a function of legal aims but also depends on what is believed to be the best ways to achieve these aims. As a result, a number of considerations pertaining to, for example, economic growth, efficiency, general societal consequences, morality and the rule of law can affect the content and scope of a particular legal rule. These considerations will often come into conflict with each other and restrict the behaviour, damage and causal relations a particular rule applies to. The impact of each of these considerations depends on the kind of responsibility that the rule imposes. Different behaviour, damage and causal relations will therefore be relevant for different rules. The entities of relevance to a particular rule are therefore, at best, imperfect and potentially misleading reflections of the legal aim of counteracting detrimental consequences of human behaviour.

Consider, by way of example, chap. 2 sec. 3, Environmental Code, which prescribes an obligation on persons who pursue an activity,[127] or intend to, to take action to implement protective

[127] The Swedish wording is "Alla som bedriver eller avser att bedriva en verksamhet eller vidta en åtgärd […]", which literally means "Persons who pursue an activity *or take a measure* or intend to […]" (my emphasis). The usage of the notion "take a measure" is meant to extend the scope of the regulation to include temporary proceedings which do not qualify as

measures and take other precautions that are necessary to prevent, hinder or combat damage or detriment to human health or the environment. According to the same section, the best possible technology ought to be used in connection with professional activities. This obligation is specified in the Government bill, according to which the technology must be economically achievable for a typical company in the actual line of business.[128] According to chap. 2 sec. 7, Environmental Code, these preventive measures need only be taken to the extent that they are not unreasonable from a cost-benefit perspective, unless an environmental quality norm is otherwise infringed. This regulation thus contains a prospective causal question about the effects of an activity which can be prevented by usage of the best possible technique which is both economically achievable for a typical company in the line of business and cost-benefit efficient. Clearly, these are not the only effects of this behaviour that the law aims to counteract. This can readily be inferred from chap. 2 secs. 9 and 10, Environmental Code, which under certain circumstances forbid activities that give rise to significant damage. Furthermore, tort rules impose liability to compensate for some damage which neither qualifies as significant nor can be prevented by means of a cost-beneficial usage of the best possible technique.[129] The considerations restricting what consequences are relevant in chap. 2 secs. 3 and 7, Environmental Code, are thus either not applicable, or do not pick out the same consequences, in legal rules imposing other kinds of responsibility. All these rules can be seen as serving the legal aim of counteracting detrimental consequences of human behaviour. Yet, the behaviour and consequences that are relevant to one such rule will differ from those that are relevant to another. No one rule will normally exhaust the human behaviour and consequences of relevance to this aim.

"activities" ("verksamheter"). (Govt. Bill 1997/98:45 part 1 p. 205.) For reasons of linguistic simplicity, the shorter notion "pursue an activity" will be used in this monograph.

[128] Govt. Bill 1997/98: 45, part 2, p. 17.

[129] See, for example, chap. 32 sec. 1, Environmental Code.

My characterization of the legal questions should be sufficiently abstract to apply to different, actual as well as potential, legal rules. At the same time, it should be sufficiently detailed to reveal features of legally relevant entities that are important in the present enquiry. In other words, it should reveal systematic differences between these entities and the entities that scientific knowledge is about which can impede the establishment of legally relevant relations through the application of scientific information. Similarly, the characterization of the legal *aim* should be sufficiently detailed to reveal ways in which the achievement of this aim is impeded by ontological differences between law and science. Neither the characterization of the aim, nor that of the questions, should be more detailed than what is required for this purpose.

Although an isolated study of one legal rule risks being misleading in these respects, a study of all of the legal rules that serve to counteract detrimental consequences of human behaviour seems unnecessarily comprehensive. Instead, a study of a relatively small number of distinct but significant rules should suffice. From it we can extrapolate some sufficiently detailed and generally applicable conclusions about the entities to which these rules apply and the aim they serve. In Sections 3.3.1 – 3.3.3, I will discuss the causes, effects and causal relations focused upon in the retrospective and prospective questions as they arise in the application of some significant rules imposing different kinds of counteractive responsibility. This discussion will provide us with a general characterization of the entities that these kinds of legal question are about. It will also give a good indication of the scope of the general aim of counteracting detrimental consequences of human behaviour.

3.3 Legally Relevant Causes, Effects and Causal Relations

3.3.1 Causes

Different rules treat different kinds of behaviour as relevant to legal responsibility. For example, the principal rule grounding tort liability, chap. 2 sec. 1 of the (Swedish) Tort Liability Act (SFS 1972:207), states that "Anyone who, on purpose or on account of negligence, causes personal or material damage shall compensate for the damage". According to this rule liability to compensate for the consequences of human behaviour presupposes conduct which, in a legal context, is classifiable as negligent. Particular behaviour may qualify as negligent by being, for example, economically inefficient or by otherwise deviating from the behaviour to be expected from a normally careful person.[130] In addition to this principal rule, there are other legal rules which prescribe liability in particular cases and which do not base this legal responsibility on negligent behaviour. Such "absolute" or "strict" liability is more common in professional activities. It is particularly common in environmental tort, and chap. 32, Environmental Code, imposes strict liability for many kinds of damage.

Tort liability is one important legal means of counteracting the extent to which damage which has already occurred affects the environment, but it is not the only one. In contrast, chap. 10, Environmental Code, prescribes liability to remedy or otherwise compensate for pollution and serious environmental harm.[131] This means an operator can be obliged, for example, to restore the environment to its baseline condition, or to take compensatory action where such restoration is impossible or has not yet been

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[130] For discussion of the understanding(s) of negligence in Swedish law, see, for example, Dahlman, *Konkurrerande culpakriterier*, 2000.

[131] See also chap. 2 sec. 8, Environmental Code.

accomplished.[132] Strict liability is the main rule according to this chapter but negligence is relevant to the scope of the responsibility.[133]

Other rules impose responsibility to counteract detrimental consequences of human behaviour by preventing such consequences from occurring in the first place. Chap. 2, Environmental Code, contains generally applicable rules of consideration, and these are complemented by more specific provisions in the Code's subsequent chapters. A fundamental general rule of consideration has already been mentioned: chap. 2 sec. 3, Environmental Code. This rule imposes a responsibility on persons who pursue an activity to take action to prevent damage or detriment to human health or the environment. Hence responsibility, according to this rule, is triggered by behaviour qualifying as an activity in the here relevant sense.[134] This includes behaviour of private persons. As also seen above, chap. 2 secs. 9 and 10, Environmental Code, affirms that activities which, despite preventive measures, are likely to cause significant damage may only be undertaken under special circumstances.

The examples given above illustrate how different rules require different kinds of behaviour for the responsibility that they prescribe to ensue. The kind of behaviour that is relevant according to a particular legal rule is a result of considerations pertaining to the kind of responsibility that the rule imposes. These considerations can relate to factors such as the seriousness of the consequences of the behaviour, the burden of the responsibility to counteract them, and the regulation's general societal impact. For example, the belief that strict liability is unjust, and the fear that far-reaching legal responsibility would threaten technical development and economic growth, can both be brought forward in support of tying tort liability to negligent behaviour. Other considerations, such as the belief that

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[132] Chap. 10 sec. 5, Environmental Code.

[133] Chap. 10 secs. 2 and 5, Environmental Code. See also sec. 23 par. 1 pt. 1, Regulation on Serious Environmental Harm (SFS 2007:667).

[134] Cf. note 127 above.

it is even more unjust to let people without direct economic interest in an activity bear its costs and the recognition of difficulties involved in proving negligence, speak in the other direction.[135]

The kind of behaviour that grounds responsibility, according to a particular legal rule, therefore depends on a balance of legally relevant considerations. This is a dynamic process and its outcome may vary over time. For example, the area of strict liability in tort law changes with both new legislation and case law. In addition, the actual behaviour triggering responsibility vis-à-vis a rule that presupposes negligence will depend on the legal understanding of negligence, and similarly, this understanding can change over time. In view of this a number of legal scholars have argued that some behaviour that previously did not qualify as negligent may do so as the environmental focus of the legislation increases.[136]

The kind of behaviour required to trigger legal responsibility will often affect what constitutes the cause in the causal relation presupposed by ascriptions of responsibility. For example, we saw above that the main rule in the Tort Liability Act prescribes liability to compensate for damage caused *on account of negligence*.[137] This is normally interpreted as implying that the negligence must have been causally related to the effect.[138] In other words, the relevant cause in these cases will consist in the negligent behaviour. When an operator's liability is instead strict it is the activity as such, or at least

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[135] See, for example, Hellner and Radetzki, *Skadeståndsrätt*, 2010, pp. 47 f. for discussion of some considerations of relevance for Swedish tort liability.

[136] Bengtsson, *Miljöbalkens återverkningar*, 2001, pp. 136 ff. See also De Sadeleer, *Environmental Principles*, 2002, p. 212. Cf. the more restrictive view taken in the Governmental Bill. (See Govt. Bill 1997/98: 45, part 1, p. 204 f.)

[137] Chap 2. Sec. 1 Tort Liability Act. See also chap. 32 sec. 1 par. 3, Environmental Code.

[138] See, for example, Hellner and Radetzki, *Skadeståndsrätt*, 2010, p. 199 and Schultz, *Kausalitet*, 2007, p. 240. See also Hart and Honoré, *Causation in the Law*, 2002 (1985), p. lx, and Wright, "Causation in Tort Law", 1985, pp. 1766 ff.

the part of it that grounds strict liability, which must be causally related to the effect.[139] Similarly, rules that impose legal responsibility to take preventive measures, or to refrain from a particular activity, are concerned with consequences resulting from the entire activity that triggers this responsibility.

In all of the rules mentioned here legally relevant causes consist in human behaviour.[140] Already a relatively narrow legal kind of entity, such as negligence, includes a variety of behaviours, such as discharges of waste water, uses of biocides without appropriate precautionary measures, the ignition of fires in dry forests, drinking and driving, and so on.[141] These behaviours often appear highly heterogeneous from certain non-legal perspectives but sufficiently homogeneous in the light of legally relevant considerations to be treated as subjects of the same kind of responsibility. As we have seen, different rules, imposing different kinds of counteractive responsibility, recognize different kinds of behaviour as relevant. It is thus reasonable to conclude that the law aims to counteract detrimental consequences of much (and from a non-legal perspective, very diverse) human behaviour. Retrospective and

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[139] Hellner and Radetzki, *Skadeståndsrätt*, 2010, p. 176. See also Hart and Honoré, *Causation in the Law*, 2002 (1985), p. lxi.

[140] My characterization of legally relevant causes in terms of human behaviour is extra-legal. Within a legal framework a professional activity is not necessarily conceived of as human behaviour but rather as the behaviour of a juridical person. Because such behaviour supervenes on human behaviour it is nevertheless appropriate to characterize it as "human" in the context of the present study, where the purpose of the characterization is to contrast it with scientifically relevant entities. The link between legally relevant causes and human behaviour is both common and natural (see Section 5.2.1) but neither ubiquitous nor necessary. For example, in the Substitution Principle in chap. 2 sec. 4, Environmental Code, it is the chemical product /biotechnical organism which is the legally relevant cause. See also Christensson, who argues that the regulation *should* focus on the natural resources used rather than on the human activities in which they are used (*Rätt och kretslopp*, 2000, p. 65).

[141] See Section 2.4 above.

prospective questions apply to behaviour for whose consequences it is regarded as appropriate to hold a person responsible in the way prescribed by a particular rule.

3.3.2 Effects

Like the causes, the kinds of effect for which counteractive responsibility is imposed differ depending on the rule in question. The Tort Liability Act and chap. 32, Environmental Code, both recognize personal injury, material damage and pure economic loss as legally relevant damage.[142] The Tort Liability Act likewise recognizes "offence" (e.g. umbrage).[143] These kinds of damage do not necessarily exhaust the range of effects that are relevant in the tort regulation. In NJA 1995, p. 249, the Supreme Court awarded the state compensation for an unlawfully killed wolverine which had been placed under protection. It has been discussed whether this decision should be interpreted as recognition of an additional kind of damage, "ecological damage" in Tort law, but the case and the discussion have not yet resulted in an amendment of the regulation.[144]

As mentioned in the previous section, chap. 10, Environmental Code, imposes responsibility to remedy environmental harm that was caused by an activity. The responsibility here does not presuppose that the harm is referable to any of the kinds of damage recognized in the tort regulation. It is, however, significantly

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[142] Chap. 2 secs. 1-2, Tort Liability Act, and chap. 32 sec. 1 par. 1, Environmental Code.
[143] The fact that chap. 2 sec. 3, Tort Liability Act, unlike chap. 32 sec. 1, Environmental Code, recognizes offence as a legally relevant kind of damage further illustrates the legal entities' relativity to legal rules.
[144] See, for example, Bengtsson, *Miljöbalkens återverkningar*, 2001, pp. 167 ff. and Schultz, *Kausalitet*, 2007, p. 113.

restricted to two kinds of environmental harm. The first of these is "pollution", which refers to contamination that may lead to damage to human health and the environment.[145] Responsibility for such pollution is subject to a rather far-reaching reasonability assessment.[146] The second kind of environmental harm is called "serious environmental harm". This includes land contamination posing a significant risk to human health as well as damage with significant adverse effects on water quality or on some natural habitats and protected species.[147]

Chap. 2 sec. 3, Environmental Code, takes a preventive instead of a rectificatory approach to environmental damage. As discussed at greater length above, this section, and chap. 2 sec. 7, Environmental Code, together target effects of an activity that can be prevented by use of the best possible technique which is both economically achievable and cost-benefit efficient.[148] Chap. 2 secs. 9 and 10, Environmental Code, impose additional restrictions on activities which, despite protective measures, are likely to cause significant damage.

Just what effects are relevant according to these rules depends, in part, on the meaning of the legal phrase "damage or detriment to human health or the environment". According to the Government bill, this phrase shall be interpreted in the light of the Code's portal section, which declares that the purpose of the Code is to promote sustainable development.[149] A widely repeated characterization of sustainable development has been given in the Brundtland report, which describes it as a "development that meets the needs of the present without compromising the ability of future generations to

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[145] Chap. 10 sec. 1 par. 1, Environmental Code.
[146] Chap. 10 sec. 4, Environmental Code.
[147] Chap. 10 sec. 1 par 2, Environmental Code. See also Directive 2004/35/CE on Environmental Liability with Regard to the Prevention and Remedying of Environmental Damage, on which this part of the Environmental Code is based.
[148] Section 3.2.3.
[149] Govt. Bill, 1997/98: 45, part 2, p. 8.

meet their own needs".[150] Sustainability is often characterized in the anthropocentric terms of the interests of (present and future) human beings.[151] However, many deny that immediate relevance to human well-being is the only factor of moral importance. For example, ecocentrists believe that ecosystems, species and/or other "ecological wholes" have an end value in their own,[152] and biocentrists ascribe moral standing to everything that is alive.[153]

Like many other legal and political documents, the Environmental Code and its preparatory works do not state their value-basis explicitly.[154] Yet it is clear that effects that do not immediately infringe human interests are also relevant in the Code. For example, the portal section of the Code states that it shall be applied so as to ensure the protection and/or preservation of *inter alia* human health and the environment, valuable natural and cultural environments, and biological diversity. It also explicitly states that nature is worthy of protection.[155] It can be speculated whether, for example, biological diversity is recognized by the law as having an end value, and thus as something that the law aims to protect in its own right, or whether it is merely seen as instrumentally valuable to, say, human health.[156] Here, it can be

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[150] World Commission on Environment and Development, *Our Common Future*, 1987, p. 43.
[151] See, for example, the discussion in Stenmark, *Miljöetik och miljövård*, 2000, pp. 27 ff.
[152] See, for example, Leopold, *A Sand County Almanac*, 2001 (1949), and his famous statement "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise" (p. 189).
[153] See, for example, Taylor, *Respect for Nature*, 1986, p. 71, where it is argued that every living thing has inherent worth.
[154] See Stenmark, *Miljöetik och miljövård*, 2000, pp. 27 ff. and p. 71. Stenmark analyzes a number of important policy documents, *inter alia* the World Commission's report *Our Common Future*.
[155] See also Govt. Bill 1997/98: 45, part 2, pp. 7 ff.
[156] Cf. Govt. Bill, 1997/98: 45, part 1, p. 214, in which the legal relevance of biodiversity is explained by reference to its "immediate importance to the environment and, *consequently, to human health*" (my emphasis).

noted that in practice, chap. 2 sec. 3, Environmental Code, is applied so as to prevent effects that do not immediately infringe any of the possible values mentioned above. For example, some responsibility to counteract increased levels of detrimental substances in the biosphere is often imposed irrespective of whether detrimental consequences of such an increase can be established in the particular case.

It is certainly conceivable that the legal relevance of, say, the impoverishment of biological diversity or increased levels of detrimental substances in the biosphere can be explained in terms of legally relevant relations between behaviours and effects that the law *aims* to counteract. Whether this can actually be done will presumably depend on how we understand the value basis underlying the Code,[157] and, again, on how we understand, for example, the Precautionary Principle[158] and the legal notion of causation[159]. The imposition of responsibility to counteract the impoverishment of biological diversity can thus perhaps be explained by saying that such impoverishment qualifies as damage that the law aims to counteract or that it gives us legally sufficient reason to assume that such damage will ensue. Hereafter I will refer

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[157] While some hold that the choice of value basis is of practical importance (e.g. Stenmark, *Miljöetik och miljövård*, 2000, pp. 167 ff.), others argue that it is not (e.g. Decleris, *The Law of Sustainable Development*, 2000, p. 51).

[158] See, for example, Westerlund, *En hållbar rättsordning*, 1997, pp. 171 f. and Persson, *What is Wrong with Extinction?*, 2008, pp. 92 ff. for discussion of the relevance of the Precautionary Principle in this respect.

[159] The legal notion of causation is discussed in Section 3.3.3 below. On one of its interpretations, called the "NESS test", the fact that the law imposes responsibility to counteract, say, discharges of detrimental substances can be explained by the fact that, since substances mix, there will basically always exist a causal relation between such discharges and some ensuing damage. (Cf. Wright, "Causation in Tort Law", 1985, p. 1793.)

to effects that the law aims to counteract, and that thus constitute immediate violations of "end values", as "intrinsic damage".[160]

However, an alternative, and in my view plausible, explanation of the apparent legal relevance of at least some of these effects is that some legal rules recognize effects that do not qualify as intrinsic damage. Thus, the fact that some such effects trigger counteractive responsibility according to these rules seems justifiable in terms of the notion that they are of a kind whose instances sometimes cause intrinsic damage, and in terms of the impossibility of ruling out such damage in the particular case. To mark the fact that such effects *always* qualify as relevant damage (irrespective of whether they will do intrinsic damage in a particular case) I will refer to this category of legally relevant effects as "*absolute* instrumental damage".

In this monograph I will assume that absolute instrumental damage is sometimes recognized as a relevant kind of damage in legal rules. In the present context it is immaterial where, more precisely, we draw the line between "intrinsic damage" and "absolute instrumental damage". My ambition here is not to specify the exact boundaries of absolute instrumental damage, but rather to recognize it as part of the legal toolbox which can be used to counteract detrimental consequences of human behaviour. Questions seeking the causal relation between particular instances of behaviour and absolute instrumental damage can be seen as intermediate: that is, they lie between questions about associations between kinds[161] and questions about relations between particular instances of behaviour and intrinsic damage. Conditions that are relevant to the occurrence of absolute instrumental damage in a particular case are certainly relevant to the answer to a question about the relation between instances of behaviour and absolute instrumental damage. In this respect, questions about absolute instrumental damage differ

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[160] What I refer to as "end value" is sometimes referred to as "intrinsic value". (The expression "intrinsic damage" is, however, ambiguous. See, for example, O'Neill, *Ecology, Policy and Politics*, 1993, pp. 8 ff. and Persson, *What is Wrong with Extinction?*, 2008, pp. 225 ff.).

[161] Cf. Section 3.2.2 above.

from questions about associations between kinds. However, no link between the behaviour and an ensuing instance of intrinsic damage needs to be established in the particular case. In this respect, questions about absolute instrumental damage differ from questions about the relation between particular instances of behaviour and intrinsic damage, too.

It should be observed, however, that the fact that, already, the establishment of a causal relation between some particular behaviour and absolute instrumental damage sometimes suffices for counteractive responsibility does not mean that intrinsic damage is irrelevant. If intrinsic damage can be expected, it should be counteracted, according to these rules, even if no intermediary effect qualifies as absolute instrumental damage and/or warrants counteractive responsibility by itself. Furthermore, intrinsic damage that can be expected to ensue given the unique conditions in an actual case may call for further counteractive measures – measures required in addition to those motivated by reference to damage of an absolute instrumental kind.

3.3.3 Causal Relations

3.3.3.1 The Legal Notion of Causation

Both the retrospective question ("Did this behaviour cause the damage?") and the prospective question ("What damage, if any, will this behaviour cause?") concern particular instances of legally relevant causes and effects. The requirement of causation that these questions express thus applies to instances of negligence and other legally relevant causal relata. It is therefore the causal relation between a *particular* instance of human behaviour and a *particular* instance of damage which is of interest when these questions are applied. The Swedish statute book does not specify what the legally relevant causal relation consists in. However, the legal and philosophical literature contains extensive discussion of the legal requirement of causation in retrospective questions. Much of this

discussion can be accounted for in terms of *how much* to include in the legal notion of causation. The following well-known example, presented by Johannes von Kries, is illustrative: A coachman becomes drunk and falls asleep while driving. The horse goes the wrong way and the carriage enters a thunderstorm. The passenger is struck by lightning and dies. The driver was negligent. The passenger would not have been struck by lightning if the horse had stayed on the agreed route, which it would have done if the driver had not got drunk (and thus if he had not been negligent).[162]

Many would hold that, in a case like this, the coachman should not be held liable for the passenger's death. Quite often this freedom from liability has been explained by the lack of a causal relation between the coachman's negligence and the passenger's death. For example, Von Kries himself held that since the deviation from the agreed route did not increase the objective probability of the passenger's being killed by lightning it was not an *adequate* cause of the patient's death.[163] Similar considerations are inherent in the doctrine of adequate causation used in many legal orders in continental Europe.[164] In Sweden this doctrine is often described as requiring that the cause raised the probability of the effect or that the effect was "in the direction of the danger".[165] Another well known argument against the existence of a causal relationship between the negligence and the damage in cases like these has been advanced by H. L. A Hart and Tony Honoré. While criticizing von Kries' recourse to probabilistic reasoning,[166] they hold that the legal notion of causation is based on the plain man's notion of causation.[167] Simply put, this notion is said to identify the last voluntary human

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[162] Von Kries, *Ueber den Begriff*, 1888, p. 201.
[163] Von Kries, *Ueber den Begriff*, 1888, pp. 200 ff.
[164] Honoré, "Causation and the Remoteness of Damage", 1971, pp. 31 f. and pp. 80 ff.
[165] Hellner and Radetzki, *Skadeståndsrätt*, 2010, p. 204.
[166] Hart and Honoré, *Causation in the Law*, 2002 (1985), pp. 467 ff.
[167] Hart and Honoré, *Causation in the Law*, 2002 (1985), p. 1.

intervention or independent abnormal occurrence as the cause.[168] This thus precludes describing the relation between earlier factors and later harm in causal terms.[169] In von Kries' example, this notion of causation can thus be used to argue that it was the lightning, rather than the coachman, which caused the passenger's death.

Although the freedom from liability in the coachman example and similar situations has often been explained in causal terms, most lawyers today would not want to explain this by means of a requirement of "factual" causation.[170] Instead, distinctions are made between requirements of factual causation and requirements of, for example, "adequate causation",[171] where the latter often are referred to the category of, strictly speaking, non-causal limitations of the area of liability. Distinctions like this are not normally intended to dismiss factual causation as legally irrelevant. Rather, factual causation is seen as a necessary but insufficient condition for legal responsibility.

The legal notion of factual causation is often conceived of as one that requires the potential cause to be a necessary condition for the occurrence of the effect, in the sense that the effect would not have happened had it not been for the cause.[172] In the example above the

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[168] Hart and Honoré, *Causation in the Law*, 2002 (1985), pp. 32 ff.
[169] Hart and Honoré, *Causation in the Law*, 2002 (1985), p. 73.
[170] A potential source of confusion here is that Hart and Honoré hold that the legal requirement of causation, on their understanding, in its entirety expresses a question of fact, in virtue of pertaining to the plain man's (and thus not only the lawyer's) notion of causation. It should be observed, however, that their usage of the term "fact" is intended to follow the distinction between matters of fact and matters of law which is used in the division of functions between judge and jury in the common-law system. (Hart and Honoré, *Causation in the Law*, 2002 (1985), p. 428, cf. Section 1.1, note 11, and Section 1.2.3, note 35, above.).
[171] Hellner and Radetzki, *Skadeståndsrätt*, 2010, pp. 195 ff.
[172] Cf. Spier and Haazen who, on the basis of 10 country reports conclude that all jurisdictions use this test as a test of factual causation ("Comparative Conclusions on Causation", 2000, p. 127). This seems to be a common understanding in Environmental tort law, too; see, for example, Larsson, *The Law of Environmental Damage*, 1999, p. 148.

coachman's negligence causes the passenger's being struck by lightning on this understanding, since the passenger would not have died had the coachman not been negligent. This understanding of the requirement of causation is often expressed in terms of the "but-for test", as it requires that the effect would not have occurred *but for* the alleged cause.

Several arguments can be advanced to support an interpretation of causation in terms of the but-for test. Requiring that the damage would not have occurred anyway guarantees that the plaintiff does not benefit from the tortfeasor's action.[173] The but-for test also seems to capture an intuitively plausible feature of a cause as something that makes a difference, and it resembles some of the most influential accounts of causation put forward in philosophy.[174] As a requirement for legal responsibility the but-for test also reflects the common idea that we should be held accountable for harm only if what we did made a difference to the harm's occurrence.[175]

Yet not everybody agrees that the but-for test captures the essence of the legal requirement of causation. An important element in Hart and Honoré's analysis of the plain man's, and thus legal, notion of causation is the conception of a "causally relevant factor".[176] Following John Stuart Mill's idea of causal conditions,[177] Hart and Honoré describe a causally relevant factor as a condition which is one of a set of conditions jointly sufficient for the production of the consequence.[178] For Hart and Honoré, this notion of a causally relevant factor is an important, but not exhaustive, part of the legal requirement of causation. What they call a causally relevant factor has also been emphasized, and made more explicit,

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[173] Hellner and Radetzki, *Skadeståndsrätt*, 2010, p. 214.
[174] See, for example, the counterfactual theory of causation advocated in Lewis, "Causation", 1973.
[175] Cf. Kutz *Complicity*, 2000, p. 3, who refers to this idea as the Individual Difference Principle.
[176] Hart and Honoré, *Causation in the Law*, 2002 (1985), pp. 109 ff.
[177] Mill, *A System of Logic*, 2002 (1843), Book III, Chapter V, §3.
[178] Hart and Honoré, *Causation in the Law*, 2002 (1985), pp. 112 f.

by Richard Wright, who refers to it as a "NESS": a Necessary Element of a Sufficient Set.[179] In the example above, the coachman's negligence is a NESS with respect to the passenger's death, since the negligence together with the thunderstorm, the lightning and other circumstances was sufficient for the passenger's death. While Hart and Honoré's explication of the legal requirement of causation aimed at capturing several features of relevance to responsibility, Wright dismisses aspects of their theory other than the causally relevant factors as non-causal considerations.[180]

In the negligent coachman example, and in many other cases, the but-for test and the NESS test will give the same result. The difference between the two tests becomes obvious in cases in which more than one sufficient set is present. This is illustrated by the following example, presented by Wright:[181] Fire X and Fire Y are, combined with other existing conditions, independently sufficient for the destruction of a house, provided that they actually reach it. In a situation in which both reach the house simultaneously, both fires will pass the NESS test as causes of the destruction of the house, while neither seems to pass the but-for test: both were necessary elements of distinct sets which were sufficient for the destruction of the house, but neither was independently necessary in the but-for sense, since in the absence of one the other fire would have destroyed the house anyway. Wright further requires the cause to be an *actual* NESS of the effect.[182] If Fire X would have reached the house and destroyed it before Fire Y arrived, the latter would not have been an actual NESS because of the absence of the condition

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[179] Wright, *Causation in Tort Law*, 1985, pp. 1788 ff. The NESS is very similar to John Mackie's analysis of causation in terms of INUS conditions: insufficient but necessary parts of unnecessary but sufficient sets. (Mackie, *The Cement of the Universe*, 1980, p. 62).
[180] Wright, "Causation in Tort Law", 1985, pp. 1741 and 1749.
[181] Wright, "Causation in Tort Law", 1985, pp. 1791 ff. and "Causation, Responsibility, Risk, Probability, Naked Statistics and Proof", 1988, pp. 1018 ff.
[182] Wright, "Causation in Tort Law", 1985, p. 1795.

consisting in the standing of the house at the time of the arrival of fire Y.[183]

The NESS test's ability to allow for causation in cases of overdetermination is an important factor; it has convinced many to abandon the traditional but-for test.[184] In Sweden, adoption of the NESS test has recently been advocated by Mårten Schultz.[185] One can acknowledge the relevance of the NESS test, however, without abandoning the but-for test. For example, in Sweden and elsewhere, it is often required that the factor grounding responsibility was necessary in the but-for sense, but this requirement is generally

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[183] Wright, "Causation, Responsibility, Risk, Probability, Naked Statistics and Proof", 1988, p 1022. A criticism of Wright's conception of an actual sufficient set can be found in Fumerton and Kress, "Causation and the Law", 2001, pp. 100 f.

[184] Cf. Wright, "Causation in Tort Law", 1985, pp. 1775 ff. and 1788 ff. It should also be noted that the NESS test's ability to handle cases of overdetermination is shared by other conceptions of causation. For example, Jane Stapleton has proposed a modification of the but-for test with effects similar to those of the NESS test. Her so called "targeted but-for test" requires that the factor of interest passes the but-for test when a notional sequence of other factors has been removed. (Stapleton, "Unpacking Causation", 2001, pp. 175 f.)

[185] Schultz, *Kausalitet*, 2007. Cf. also Andersson, *Skyddsändamål och adekvans*, 1993, p. 311. Unlike Schultz, Andersson does not explicitly encompass the NESS test. However, he holds that the causal requisite only amounts to the requirement that the factor grounding responsibility actually acted in some way, whether as a necessary *or* a sufficient condition of the effect. As long as one of these conditions obtains, the legal requirement of causation is met, according to Andersson. (It should be mentioned that Andersson, unlike, for example, Schultz and Wright, is concerned with the non-causal boundary of liability). If, as Wright argues, passing the but-for test automatically means that the NESS test is passed, Andersson's understanding of causation seems to be in accordance with the latter, let alone that the NESS test is more sophisticated than the notion of a sufficient condition. (If, however, the world is indeterministic, the fact that a condition passes the but-for test does not imply that it likewise passes the NESS test. See Fumerton and Kress's criticism in note 195 below).

relaxed when each of two factors which together with other conditions were sufficient for the effect was associated with fault. The relaxation is motivated by the consideration that two people at fault should not benefit from each others' fault.[186] Aleksander Peczenik has explained this variance by allowing for both "weak" and "strong" causation, corresponding to the NESS test and the but-for test, respectively.[187] According to Peczenik, it is a legal matter to decide which kind of causal relation to require in a certain legal context (and thus whether the but-for test or the NESS test shall apply there).[188]

Most advocates of the NESS test, however, claim that the NESS test *alone* expresses the legal requirement of causation. These supporters of the NESS test need not deny that the but-for test can be legally relevant: for example, Hart and Honoré acknowledge that the but-for test is relevant to causation outside the law, and that the obligation on a plaintiff to show an economic loss in civil law implies a requirement to show that the cause was necessary in the circumstances. They merely deny that this requirement expresses a legal causal principle.[189] Wright acknowledges that the but-for test can be relevant to the plaintiff's corrective justice claim that he would not have been injured if not for the tortious conduct of others, but points out that this is a policy-laden question of damages and not a question of causation.[190] Wright thus refers the but-for test to the category of non-causal considerations pertaining to the boundaries of legal responsibility.[191]

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[186] See, for example, Hellner and Radetzki, *Skadeståndsrätt*, 2010, p. 216.
[187] Peczenik, *Causes and Damages*, 1979, pp. 6 ff. Peczenik also allows for a third kind of causation, so-called "redundant causation".
[188] Peczenik, *Causes and Damages*, 1979, p. 8.
[189] Hart and Honoré, *Causation in the Law*, 2002 (1985), p. 250.
[190] Wright, "Causation in Tort Law", 1985, p. 1798.
[191] Wright, "Causation, Responsibility, Risk, Probability, Naked Statistics and Proof", 1988, p 1022, Similarly, Jane Stapleton admits that necessity in the but-for sense can be relevant to legal responsibility. However, she argues that decisions about relevance here are normative, and that the incidental requirement of this kind of necessity, like other questions

Although much of what I say below will be neutral with respect to the precise understanding of causation adopted, I will use the NESS test and the but-for test in the course of providing examples and substantiating specific points in my discussion. These understandings of the legal requirement of causation are sufficiently important both in Swedish and international jurisprudential discussion and legal practice to warrant this special attention. Having said this, I should point out that these tests have not been universally embraced as expressions of the legal requirement of causation. For example, some have argued that this requirement should be understood as (or replaced by) a requirement that more care would have reduced the probability of the effect.[192] Others have claimed that it is misdirected, or even pointless, to explicate the legal requirement of causation.[193] Furthermore, the NESS test – which, according to Wright, "is not just a test for causation, *but is itself the meaning of causation*"[194] – is not without its problems. As discussed by Fumerton and Kress, the notion of an actual sufficient set seems to be problematic, and the test controversially presupposes determinism, ruling out indeterministic causation.[195] Thus, it can certainly be

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about legal policy and principles relevant to responsibility, shall be accounted for by non-causal means (Stapleton, "Unpacking Causation", 2001, p. 167 and p. 175 f.). For a similar view in the Swedish discussion, see Schultz, *Kausalitet*, 2007, p. 379 and p. 467.

[192] Landes and Posner, "Causation in Tort Law", 1983, p. 110 and p. 112.

[193] See, for example, Malone, "Ruminations on Cause-in-Fact", 1956, pp. 61 ff., who argues that policy is often also a factor in what is conceived as legal "cause-in-fact" issues.

[194] Wright, "Causation in Tort Law", 1985, p. 1802 (my emphasis).

[195] Fumerton and Kress, "Causation and the Law", 2001, p. 89, p. 97 and pp. 100 ff. With respect to indeterministic causation, Fumerton and Kress discuss an example in which someone plants a bomb which is activated by the decay of a radioactive element with a half-life of a thousand years. The bomb decays after five minutes and serious damage ensues. If radioactive decay is assumed to be genuinely indeterminstic, there was no sufficient set with respect to this damage. The bomb, which was a cause of the damage according to the but-for test, would therefore not be

questioned whether the NESS test fully captures the "true", or even the prevalent, legal meaning of causation.

Moreover, the NESS test and the but-for test rely on regularities and counterfactual reasoning, and many philosophers deny that regularities or counterfactuals are constitutive of causation and rather conceive of causation as some kind of physical process or concrete relation. [196] This relation, which to date nobody has been able to explicate in detail, is sometimes referred to as "biff".[197] At face value, much of the less theory-laden language used to describe the causal relations of relevance in case law actually suggests that it might be something like the biff which the law is after. [198] There, a cause is often referred to in non-conditional terms as something that makes a "material contribution" to,[199] or has a "determinative influence" on,[200] the effect. If these formulations are interpreted as manifestations of a legal requirement for a biff to be established, the NESS test and the but-for test can both be seen as more or less useful and hence instrumentally valuable indicators of when such a requirement is met; but *pace* Wright they need not characterize the very nature of the required relation.

The retrospective question and the causal relation it presupposes concern instances of legally relevant causes and effects. These instances occur without isolation in a natural context and are often largely separated in time and space. In such a context, absences

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classified as a cause by the NESS test. (Fumerton and Kress, "Causation and the Law", 2001, pp. 97 f.). Yet it seems highly plausible to ascribe legal responsibility on causal grounds in a case like this. Stapleton's targeted but-for test (see note 184 above) seems to handle indeterministic causation better than the NESS test does.

[196] See, for example, Anscombe, "Causality and Determination", 1993 (1971), pp. 91 ff. and Bogen, "Regularities and Causality", 2005, p. 399.

[197] Handfield et al. "The Metaphysics of Causal Models", 2008, p. 150.

[198] It can be noted that the biff account of causation does not preclude causation in cases of omission. (See Handfield et al. "The Metaphysics of Causal Models", 2008, pp. 155 ff.)

[199] *Bonnington Castings Ltd. v. Wardlaw*, 1956, at 620.

[200] NJA 1983 p. 606 at 610.

and presences of a potentially infinite number of conditions other than the cause will be relevant to the occurrence of the effect. On every interpretation of causation which takes this influence into account a causal relation between a *particular* legal cause and a *particular* legal damage will therefore depend on a potentially very large number of conditions. For example, a given NESS will presuppose the existence of all of the factors required to constitute a sufficient set. These will include not just all of the factors, such as genetic constitution, lifestyle and environment, which must be present for such a set to exist, but all of the factors which must be absent. In order for a condition to be a cause in the but-for sense, these absences and presences must not make up a sufficient set without that condition. Even if only the biff is believed to capture the true nature of the required relation, knowledge that a biff obtains normally seems to presuppose knowledge of the obtaining (or failure to obtain) of sets of sufficient factors.[201] As will soon be explained at greater length, absences and presences of conditions that are relevant to the occurrence of the effect will affect the probability of the effect and thus be relevant to the existence of a causal relation on a probabilistic interpretation of causation, too.[202] Hence, the existence of the causal relation the retrospective question seeks will depend on the absences and presences of a potentially very large number of conditions.

3.3.3.2 Beyond the Paradigm

Whereas the nature of the causal requirement in the retrospective question has been discussed extensively, its counterpart in the prospective question has more or less escaped scrutiny. Clearly,

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[201] Conditions may therefore be important for epistemic reasons. See, for example, Bogen, "Regularities and Causality", 2005, p. 417. See also the discussion of the difficulties involved in perceiving causation in Chapter 4 below.

[202] See the discussion of possible understandings of the causal requirement in the prospective question below.

there is much discussion of matters *related* to the causal requirement – e.g. effective methods of securing a robust decision basis or appropriate approaches to uncertainty. However, it has rarely been asked what the causal requirement in the prospective question actually consists in. This theoretical lack can, perhaps, be explained in part by the fact that this question belongs to a relatively new approach to environmental damage. For a long time environmental law was largely based on tort law's retrospective and rectificatory approach to damage. The need for a complementary, preventive approach, involving prospective causal questions, was not fully recognized until the second half of the twentieth century.[203] This change in approach brought with it a need for a good deal of novel resource-consuming theoretical work – work associated with the fundamentally new regulatory approach. Another possible reason for the apparent lack of interest in the notion of causation in the prospective question is that this notion has simply been assumed to be identical to that in the retrospective question. Even so, it is at least conceivable that a somewhat different notion of causation is required by the prospective question. An investigation of the possibility of answering retrospective and prospective questions through the application of scientific information requires an assessment of this and other possible differences, between these questions.

To begin with, it can be noted that, like the retrospective question, the prospective question asks for the relation between particular instances of legally relevant entities. Like the relation of relevance in the retrospective question, this relation occurs in a natural context. However, the retrospective and the prospective questions are not perfectly analogous. An obvious and already indicated difference between the two questions is that the prospective question is about effects that have not yet occurred. Because the question is about the future, many of the factors that will immediately affect the occurrence of the effect will not be in place at the time the question is being asked. These factors, too, will therefore

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[203] De Sadeleer, *Environmental Principles*, 2002, pp. 15 ff. and pp. 61 ff.

depend on the absences and presences of a potentially very large number of other causally relevant factors. When the retrospective question is being asked, the relevant effect and these other conditions have all occurred, and they can provide important clues about the existence of such factors. The state of knowledge with respect to factors of relevance for occurrence of the effect is therefore typically better when the retrospective question is being asked than it is when the prospective question is being asked.

It can be called into question whether the highly limited state of knowledge calls for another understanding of the causal relation that the prospective question asks for. One plausible option (which sometimes has been suggested as appropriate for retrospective questions, too) is to conceive of this relation in probabilistic terms. For example, an activity could be regarded as a cause of particular damage if it increases the probability that the damage will occur.[204] Because already a particular legally relevant condition, such as the presence of a detrimental substance, often seems to affect the probability of the damage, it may appear that the existence of the causal relation that the question (on this interpretation) seeks depends on a limited number of conditions only. In epistemically complicated situations like those in which the prospective question is asked a probabilistic understanding of causation may therefore seem more appropriate than, say, an understanding couched in terms of comprehensive sufficient sets.

This epistemic benefit of a probabilistic interpretation of the causal relation is, however, illusory. An objective probability of a singular event is (if it at all exists) a function of every condition on which the occurrence of the effect depends.[205] Hence it depends not just on the presence of the detrimental substance, but likewise on all other relevant conditions in the surrounding environment.

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[204] Many philosophers have suggested the adoption of probabilistic notions of causation. See, for example, Suppes, *A Probabilistic Theory of Causality*, 1970, and Eells, *Probabilistic Causality*, 1991.

[205] See, for example, Dupré, The *Disorder of Things*, 1993, pp. 194 ff. for discussions.

Consequently, the existence of a causal relation understood probabilistically also depends on the absences and presences of a potentially very large number of conditions. It is another matter that a justified *belief* that a factor increases the probability of the effect may permit one to *infer* the existence of the relation in a particular case. As is well known, legal proof does not require full certainty. Therefore legal inference to the existence of a causal relation does not require knowledge of all relevant conditions. Even so, the fact that other relevant conditions may defeat such inferences seems to show that it is not the increased subjective probability as such that constitutes the legally relevant relation. The standard of proof, which also differs with the context, should not be conflated, then, with the relation that the questions ultimately focus upon.

Thus, because it is a relation between particulars in a natural context, the existence of the relation that the prospective question targets inevitably depends on a potentially very large number of absent and present conditions. This is not to say that further discussion of the appropriate way to understand the relation that this question seeks will be meaningless. On the contrary, discussions of this kind are likely to shed further light on both the causal requirement in the prospective question and the legal requirement of causation in general. For example, it would presumably be fruitful to discuss whether the relation sought when the prospective question is raised is best understood in terms of the but-for test or the NESS test. If the causal requirement in the prospective question is interpreted in accordance with the but-for test, the activity is a cause if the damage would occur in the presence, but not in the absence, of it. If the causal requirement is instead interpreted along the lines of the NESS test, the activity is a cause if it is a necessary element of a set which is sufficient for the occurrence of the damage. *Prima facie*, a couple of arguments seem to favour the NESS test here. To begin with, the word "result"[206] in chap. 2 sec. 3, Environmental Code, implicitly refers to sufficiency. The obvious fact that an activity or measure

[206] In Swedish "medför".

rarely, if ever, is sufficient for damage in itself, requiring additional conditions, suggests the notion of a sufficient set of which the activity forms part. Moreover, many environmental problems result from the actions of a large number of persons, or bodies, which together give rise to, and causally overdetermine, the ensuing damage. Thus, in the context of environmental law, the but-for test would not only constitute a rare and/or hypothetical barrier to the imposition of counteractive responsibility; it would actually significantly limit the impact of legal rules. This is a powerful argument in favour of an understanding of the causal relation in terms of the NESS test here. It also suggests that examples from environmental law can be fruitfully examined in more general discussions of the legal notion of causation.[207]

Nothing said so far suggests, however, that the relations targeted by the retrospective and prospective questions differ in any respect that is of relevance to the present enquiry. Just like the causal relation sought when the retrospective question is raised, the causal relation focused upon in the prospective question is a relation between particular instances of human behaviour and damage in a natural context. Whether the relation is retrospective or prospective its existence will depend on absences and presences of a potentially very large number of conditions. However, the *questions* as such differ in ways that are potentially important in the present enquiry.[208]

To begin with there is an important difference in the way the retrospective and prospective questions *identify an effect*. As already said, both questions seek relations between particular behaviour and particular damage. The retrospective question, however, obliges us to look for the causal relation between the cause and a particular *ostensively identified* effect. As a result, every causally relevant feature on which the relation between the cause and the particular effect

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[207] Steps in this direction are taken in, for example, Wright, "Causation in Tort Law", 1985, pp. 1792 ff. and in Kutz, *Complicity*, 2000.

[208] Cf. the referred discussions of causation in medicine and law in Section 2.4.

depends is relevant to the answer to this question. The prospective question, on the other hand, is direct on causal relations between the cause and particular effects which need not be ostensively identified, since they can be identified via their affiliation with a legally relevant *kind*. Although some kinds of difference between distinct instances of damage are legally relevant, every difference is not in itself legally relevant. For example, it will presumably make a legally relevant difference whether the damage consists in changes in the genes of fish or malign tumours among humans. However, it will presumably *not* make a legally relevant difference whether it is the genes of pikes or perches that will be affected. More obviously, because of the principle of equality before the law, it *must* not make a legally relevant difference what particular human being is affected. Some conditions of relevance to what particular fish or human being will be affected, and thus to the answer to the retrospective question, are therefore simply not relevant to the answer to the prospective question. This difference may appear small, but, as we shall see in Chapter 6, it has a significant bearing on the possibility of establishing legally relevant causal relations by means of these two questions and scientific information.[209] Another important difference is that between the questions' temporal perspectives, and consequently between the *points in time* at which they are asked. The questions can apply to the same relation, but whereas the retrospective question is asked after the effect has occurred, the prospective question is asked before. As will be elaborated at greater length in Chapter 6, this difference, too, is relevant to the possibility of establishing legally relevant relations by means of these questions.

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[209] Because the prospective question identifies relevant effects through their affiliation to a legally relevant *kind*, the same question asks for all relations between the legally relevant behaviour and effects which belong to this kind. As explained below (Section 6.4 note 309), this difference is not immediately relevant to the present investigation of the possibility of establishing legally relevant relations by means of these questions and scientific knowledge. It will therefore not be dealt with in any detail here.

Finally, it can be noted that, in theory, the relations sought when legal *rules* are applied may differ qualitatively from the relations of immediate relevance to the legal *aim*. The legal rules that have been discussed here typically impose responsibility to counteract damage caused by human behaviour. Sometimes, persons are held responsible for the behaviour of others, but in most cases they are held responsible only for the effects of their own behaviour. Consequently, these rules typically require the existence of a causal relation between a particular piece of damage and the behaviour of a legally relevant individual person. This link to individual behaviour is not necessarily relevant to the legal aim in the same way as it is relevant to legal rules. For example, it is certainly conceivable that the law aims to counteract damage which would not have occurred *but for all* legally relevant human behaviour. This interpretation of the aim-relative relation between behaviour and damage need not conflict with a divergent, instrumental understanding of the relation required by legal rules. For example, in cases of overdetermination, an effect passing the NESS test but not the but-for test with respect to the behaviour of a particular person can nevertheless pass the but-for test with respect to *all* legally relevant human behaviour. It is another matter that such divergent causal tests with respect to aims and rules can conflict insofar as they are interpreted as non-instrumental expressions of the true *meaning* of causation.

3.4 Conclusions and Two Hypotheses

In this chapter part of what the law aims to achieve has been described as the *counteraction of detrimental consequences of human behaviour*. Two kinds of question that arise in the application of many rules serving this aim have been discussed in detail. These are: 1) *Did this behaviour cause the damage?* and 2) *What damage (if any) will this behaviour cause?*

As we have seen, different rules pick out different kinds of behaviour and damage as relevant to the kinds of responsibility they

impose. These kinds will include varieties of behaviour and damage that are sufficiently homogeneous in the light of considerations of relevance to the particular rule to justify their being associated with the same kind of responsibility. However, the varieties of behaviour and damage to which these rules apply are often highly heterogeneous when looked at from the point of view of other, non-legal considerations. These two kinds of legal question and the aim they serve are thus directed on a great variety of human behaviour and damage. In addition to the damage that the law ultimately aims to counteract, some legal rules that give rise to these questions recognize some effects which tend to give rise to such damage. This legally relevant kind of damage has been referred to here as "absolute instrumental damage". Damage of a kind that the law ultimately aims to counteract has been referred to as "intrinsic damage".

Both the retrospective and the prospective questions ask for relations between particular behaviour and particular damage in a natural context. Irrespective of how the required relation is understood, its existence typically depends on the absences and presences of potentially very large number of causally relevant conditions. The appropriate interpretation of this relation is a matter for debate. This chapter has looked at two candidates for this interpretation: the but-for test and the NESS test. On the former the effect must be such that it would not have occurred in the absence of the candidate cause. On the latter the candidate cause must be a necessary element of a set of conditions that is sufficient for the occurrence of the effect.

Although nothing that has been said suggests that retrospective and prospective questions target different kinds of relation, the questions do differ. Whereas the retrospective question identifies the effect ostensively, the prospective question identifies it in terms of its affiliation with a legally relevant kind. Moreover, the retrospective question is, by definition, put after the relevant effect has occurred, and hence at a later stage than the prospective question.

At this stage the following two hypotheses can be formulated:

- (*H1*) *the entities that the two legal questions are about differ from scientifically known entities*
- (*H2*) *these differences will systematically hamper efforts to establish the relations sought when questions of the two sorts are raised*

In subsequent chapters these hypotheses will be tested.

4 Scientific Knowledge of Causation

4.1 Introduction

In this chapter I portray some characteristics of scientific knowledge with a particularly important bearing on the possibility of answering legal questions about causation. Section 4.2 explains, in brief terms, in what ways science and scientific knowledge are relevant in this respect. Section 4.3 provides a characterization of scientifically known causes and effects, and in Section 4.4 a connected characterization of scientifically known causal relations is offered. Section 4.5 summarizes the most important conclusions of the chapter.

4.2 The Aim of Science and Scientific Knowledge of Causation

In the introduction to his famous essay "Aspects of Scientific Explanation" Carl Hempel identified man's intellectual curiosity and his will to survive and improve his strategic position in the world as the principal stimuli of scientific efforts.[210] This description seems to capture the incentives of science rather well, while also applying to

[210] Hempel, "Aspects of Scientific Explanation", 1965, p. 333.

the less systematic and somewhat unstructured search for knowledge undertaken by people in ordinary life, from which science originates. Clearly, the aim of an activity whose principal stimuli are intellectual curiosity and the improvement of strategic positions is going to be very ambitious. As far as scientific knowledge of causation is concerned, the *ultimate* end-product of scientific endeavour would presumably include practically every causally relevant element of the world as well as every respect in which each such element is causally relevant.[211] Simply put, it would amount to a complete map of the world's causal structure.

Speculation about the character of such an ultimate end-product of scientific efforts is bound to be intriguing. In practice, however, when we seek to answer legal (and other) questions by means of scientific knowledge we are obliged to place our trust in the *actual* state of scientific knowledge. Certainly, the actual state of scientific knowledge will, in part, be a function of the causal structure of the world that science ultimately aims to explain. However, it will also depend on the possibility of obtaining knowledge of the world, and on whatever studies have actually been conducted. These factors, too, depend on what the world is like, but they reflect as well the interests, values and choices of scientists, their funders, and the scientific community that they work in. Actual scientific knowledge is therefore systematically constrained in relation to the state of scientific knowledge science ultimately strives to reach. The purpose of this chapter is to discuss the character of the entities that much of

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[211] Discussions of the appropriateness of some kinds of research suggest that there may be some limits to what knowledge we, as human beings, regard as desirable. Whether these considerations should be taken into account by science and scientists, or whether instead they belong to the political arena, is a matter for debate. (See, for example, Lakatos, "The Social Responsibility of Science", 1978, p. 258, according to whom "[…] *science, as such, has no social responsibility*. In my view it is society that has a responsibility – that of maintaining the apolitical, detached scientific tradition and allowing science to search for truth in the way determined purely by its inner life".)

the scientific knowledge which has passed through these constraints is about.

In this monograph "scientific knowledge" refers to theories, hypotheses and other propositions which, from a scientific point of view, are regarded as confirmed.[212] The characterization given in this chapter is intended to apply not only to scientific knowledge as it is today, but likewise to scientific knowledge as it will be in the foreseeable future. Consequently, it applies not only to what *has been* confirmed, but to what *can be* confirmed, and hence to much theorizing that amounts, at the present time, to no more than educated speculation. Because I will use this characterization to illustrate the *limits* of scientific knowledge, its inclusiveness will not threaten (but rather strengthen) the validity of the conclusion I draw by means of it. A risk that appears to be associated with a flexible characterization of this kind is that it will simply become uninformative. However, as we shall see in the next chapter, the characterization of scientific knowledge given here is informative enough to reveal some interesting contrasts with the legal questions that this knowledge often is used to answer. It should finally be observed that not every aspect of scientific knowledge is of equal importance to the possibility of establishing legally relevant relations; and, as will be discussed in more detail in passing, the characterization provided in this chapter will concentrate on features and parts of scientific knowledge which are especially important in this respect.

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[212] See Sections 1.2.1 and 1.2.3.

4.3 Causal Relata[213]

Science has made us aware of many previously unknown causal phenomena. Many of these involve occurrences with which we are already acquainted but which we previously did not know to be related. A familiar example is the correlation between second-hand smoke exposure (environmental tobacco smoke, or "ETS") and physical ill-health. Following the results of comprehensive scientific research, ETS is today considered responsible for the annual killing of hundreds of thousands people.[214]

Although much scientific enquiry begins with the establishment of associations between "ordinary" phenomena, such as smoke and ill-health, or even death, this is normally not where enquiry ends. Thus, it is often said that scientific explanation involves the finding of the causes that *underlie* these causally complex phenomena and thus a reduction of the latter to their more basic components.[215] For example, science has found several dozen carcinogens in cigarette smoke.[216] These substances are causally relevant constituents of ETS but, unlike it, they are entities with which we would not have been acquainted had it not been for science. By discovering these underlying entities and the mechanisms by which they operate, science does not merely inform us about the fact *that* ETS gives rise to physical ill-health; it tells us *how*, more precisely, it does so.[217]

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[213] In a causal chain the same entity can play the role of both cause and effect. Science is interested in both these roles. In contrast with my discussion of legally relevant causes and effects, which more rarely overlap, my characterization of scientifically relevant causes and effects will therefore be presented under the same heading.

[214] It is, for example, estimated that, through its association with heart disease, ETS kills 60 000 Americans annually (Baird and Cann, *Environmental Chemistry*, 2008, p. 170).

[215] See, for example, Bechtel and Richardson, *Discovering Complexity*, 1993, p. 231 and Cartwright, *How the Laws of Physics Lie*, 1983 p. 58.

[216] Baird and Cann, *Environmental Chemistry*, 2008, p. 169.

[217] Machamer et al, "Thinking about mechanisms", 2000, p. 21.

As scientific knowledge deepens, what is at first regarded as a single kind of cause, the tobacco smoke, may, then, be decomposed into a number of distinct kinds of entity. One factor of importance in scientifically made distinctions between these entities is their causal heterogeneity. Entities that differ with respect to the effects to which they give rise, or the conditions under which they do so, will have different roles in the scientific explanations they enter. Therefore, the discovery that the effects of an entity x in a given set of circumstances differ from those of x' under the same circumstances will typically speak in favour of referring x and x' to distinct scientific kinds. Conversely, causal and structural *homogeneity* are important features of scientifically relevant similarity. Thus if, in a range of circumstances, the effects of x were instead found to be the same as those of x', there would be a case for referring x and x' to the same scientific kind.

However, a distinction that can be made on the basis of causal heterogeneity will not be fruitful in every context. The finer the distinction of a kind is, the fewer instances will it have. The fewer instances it has, the more difficult will it be to obtain knowledge of its causal relevance (see Section 4.4 below). Unless the causal heterogeneity concerns *relevant effects*, a distinction based on it will, unnecessarily, decrease the available empirical material and thereby the possibility of drawing reliable conclusions from it. The importance of causal heterogeneity as a basis of scientific distinctions is thus typically limited to contexts in which the effects to which the heterogeneity refers are of interest. For example, consider two tumours which differ slightly in shape. These tumours give rise to different images in a screening and, hence, are causally heterogeneous in this respect. This difference is perhaps relevant to questions about how, precisely, the surgical treatment is to be conducted, but not necessarily to other issues, such as the chance of recovery.[218] So in a context where it is the chance of recovery that is

[218] This is not to deny that *some* aspects of tumour shape can be relevant to recovery.

of interest, it is not necessarily fruitful to distinguish between different kinds of tumour on the basis of shape. Because the relevant interests, as said in the previous chapter, differ between scientific disciplines, a distinction which is relevant in one scientific context need not be relevant in others.

Distinctions that are suspected to be relevant with respect to a particular kind of effect will deplete the empirical material, too. Therefore it is sometimes more fruitful to stick to kinds that are known to be somewhat causally heterogeneous also with respect to relevant effects. Consequently, many scientific kinds include entities that are known to be somewhat causally heterogeneous with respect to the kinds of effect that they are used to explain and predict. This is particularly so with respect to scientific kinds at the macro-level. At present, ecology, medicine, meteorology and other "special sciences" recognize many kinds (species, organs, clouds, and so forth) which are less homogeneous than the typical chemical and physical kinds (molecules, elementary particles) which, to a greater extent, belong to the micro-level.[219] This difference is at least part of the reason why the special sciences have so far been less successful than physics and chemistry in finding general, exceptionless "laws". Biological "laws", for example, are often probabilistic; they are also highly domain-sensitive.[220] Consequently, the predictions offered by special sciences like biology and meteorology are generally not as reliable as those in physics and chemistry.[221]

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[219] This is a generalization. Medicine, ecology and other special sciences include a number of sub-disciplines, some of which are concerned with relatively homogeneous micro-level entities, too. (See, for example, Brooks et al. *Law and Ecology*, 2002, pp. 7 ff. and Mayr, "Causes and Effects in Biology", 1961, pp. 1501 ff.).

[220] See, for example, Mayr, "Causes and Effects in Biology", 1961, p. 1505, and Mitchell, *Biological Complexity and Integrative Pluralism*, 2003, pp. 115 ff.

[221] Mayr, "Causes and Effects in Biology", 1961, pp. 1504 ff. See also Shrader-Frechette and McCoy, *Method in Ecology*, 1993, p. 5, according to whom "general ecological theory was and is not precise enough to help adjudicate courtroom conflicts over environmental welfare". Another

Because of these differences the special sciences are sometimes regarded as less mature, or less scientific, than physics and chemistry. Some commentators believe that everything that takes place in the world is in theory explainable in terms of happenings at the micro-level and that eventually, as scientific knowledge deepens, the special sciences will be reduced to these more fundamental sciences.[222] Indeed, there are many examples of successful reductive scientific explanations running from macro-level to micro-level. A well-known example is the molecular theory of heat, by which temperature is explained by its molecular composition and motion. There is also an intuitive appeal of the idea of hierarchical connections between micro and macro-level. Nevertheless, many have rejected the prospect of scientific unification as impossible in practice, or even in theory. This rejection is often based on recognition of the complexity of the world that science aims to explain.[223]

Whether or not comprehensive scientific reduction will be possible in the future, it is certainly not possible today. It is undeniable that the predictions that ecological theory can make of, for example, the effects of the introduction of a new species in a particular ecosystem are highly imperfect. Even so, it seems clear that a theory which applies at a finer level of granularity would do even less well if used for the same purpose. Thus, a theory of elementary particles would presumably have to be overwhelmingly complex in order to succeed nearly as well as ecological theory does in this respect. Furthermore, adequate theories to bridge the

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possible part of the explanation is that the relations that the special sciences are about are less sensitive to variations in the environment than those that physics and chemistry are about. Also, however, as is stressed by Cartwright, the adequacy of predictions made by physical theory depends on the environment (*How the Laws of Physics Lie*, 1983, pp. 54 ff.).

[222] See, for example, the discussion in Oppenheimer and Putnam, "The Unity of Science as a Working Hypothesis", 1958.

[223] See, for example, Cartwright, *The Dappled World*, 1999, Dupré, *The Disorder of Things*, 1993, pp. 85 ff. and Mitchell, *Biological Complexity and Integrative Pluralism*, 2003, pp. 179 ff. for some sceptical arguments.

theoretical divisions here are generally missing.[224] Physical and chemical theories are – at least, for the present time – simply not the best means to account for these occurrences, which instead are better captured in terms of more causally heterogeneous macro-level kinds of entity.[225]

Scientific knowledge of the effects of some chemical substances provides a somewhat different, but legally interesting, example of scientific irreducibility.[226] Many detrimental effects on human health or the environment have been seen to follow from relatively large quantities of such substances. Thus, it is scientifically established that large amounts of carbon dioxide are causally associated with global warming,[227] and large quantities of CFCs with holes in the ozone layer.[228] Quite often, small quantities of substances like these will not give rise to detectable effects of a similar kind when studied. One possible reason for the inability to detect effects of smaller quantities is that there is a threshold of the substance, below which no effect of the relevant kind occurs. However, it may also be that an effect occurs below that "threshold" but is too rare, or otherwise too small, to be detectable according to the scientific standards of proof applied in a study of manageable size. (The fact that the size required to detect some effects easily becomes a problem is nicely illustrated by Alvin Weinberg. In his example, no fewer than 8 000 000 000 mice (!) are required to determine, at the frequently applied 95 per cent confidence level, whether 150 millirems will increase mutation rate by 0.5%.[229]) Whether or not natural thresholds exist is often impossible to know. Therefore the causal relevancy of smaller quantities cannot be straightforwardly inferred from the established

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[224] See, for example, Cartwright, *How the Laws of Physics Lie*, 1983, p. 50 and Mitchell, *Biological Complexity and Integrative Pluralism*, 2003, pp. 207 ff.
[225] See Section 1.2.2 note 25.
[226] See Section 7.4.3.
[227] Baird and Cann, *Environmental Chemistry*, 2008, pp. 217 ff.
[228] Baird and Cann, *Environmental Chemistry*, 2008, pp. 77 ff.
[229] Weinberg, "Science and Trans-Science", 1972, p. 210.

causal relevance of a larger quantity. Extrapolations from high doses to low doses are sometimes made, but these require more or less hypothetical assumptions about the linearity of the relation between dose and effect.[230] If the relation is assumed to be non-linear, extrapolation to lower doses may be unwarranted. Hence, the actual causal relevance of small quantities of many substances is presumably at present epistemically inaccessible.[231]

It can be seen, then, that even if with perfect knowledge the world could be explained by means of a few fundamental kinds of entity within a single theoretical framework, this is not the picture that science has begun to paint. Rather, the scientific image indicates the existence of a highly complex world. Our scientific knowledge of this world includes a very rich flora of distinct causally relevant kinds located on a very large number of levels and within a large number of theoretical approaches. Many of these entities will overlap, but the majority of them are non-redundant parts of the causal explanations that science can provide today. Furthermore, new chemical compounds, hereditary traits, diseases and other scientifically relevant kinds are constantly discovered or postulated. This, as well as the imperfect predictions of many scientific theories, suggests that many causally explanatory kinds are still waiting to be demarcated. In spite of their richness, it is thus in the nature of the scientific categorizations that they are fragmentary with respect to the causal relevance of the world that science aims to explain.

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[230] See, for example, Morgan and Henrion, *Uncertainty*, 1992, p. 59 and Sahlin and Persson, "Epistemic Risk", 1994, p. 52.

[231] As will be discussed in the next few chapters, these examples are legally relevant because the quantity for which a person can be held responsible is often smaller than the quantity from which a detectable effect has been seen to follow.

4.4 Causal Relations

4.4.1 Perceiving Causation

In the previous chapter the causal relations targeted by the two key legal questions – i.e. the prospective and retrospective sort – were described as relations holding between particular instances of human behaviour and damage in a natural context. In these relations the occurrence of the relevant effect will depend on absences and presences of a potentially very large number of conditions in addition to the relevant cause. On most interpretations of causation, so too will the existence of a causal relation between the cause and effect.

The acquisition of knowledge of the causal relation between particular instances is not without its problems. The eighteenth-century philosopher David Hume famously denied that we are able to perceive such relations. "[T]here is not", he wrote, "in any single, particular instance of cause and effect, any thing which can suggest the idea of power or necessary condition."[232] According to Hume, the notion of a cause is something that arises in our mind when a kind of particular is uniformly conjoined with another kind. We thus *suppose* that there is a connection between the two kinds. We do not, however, *perceive* the connection. Instead, it is a habit in our mind to expect instances of the second kind to follow instances of the first.[233]

There is an important and much discussed *metaphysical* aspect of Hume's observation: if we cannot perceive these causal relations between particulars, it can justifiably be called in question whether they really exist. Consequently, some philosophers think that we should adopt a sceptical attitude to this kind of entity and instead build our metaphysics on what we do perceive, namely the regularities between instances of the same kinds.[234]

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[232] Hume, *An Enquiry Concerning Human Understanding*, 2004 (1748), p. 39.
[233] Hume, *An Enquiry Concerning Human Understanding*, 2004 (1748), p. 47.
[234] See, for example, Beebee, "Does Anything Hold the Universe Together?", 2006, and Mackie, *The Cement of the Universe*, 1980.

Many philosophers, however, have objected to Hume's point that judgments about causation presuppose some idea about a general causal relation. Consider the following counterexample devised by Douglas Gasking, as depicted by David Armstrong:

> A small piece of stuff is observed to be dropped into a glass of liquid, in a laboratory, say. The next thing perceived to happen is that the glass explodes violently. Under these circumstances we would have little doubt that we had witnessed a particular causal sequence. The dropping of the stuff into the glass caused the explosion. But we might have absolutely no idea what was the regular sequence involved.[235]

The example suggests that singular causal sequences, *pace* Hume, *can* be perceived and that judgments about these sequences do not necessarily presuppose knowledge of regularities. Because some singular sequences appear to be perceivable in this way, some writers have rejected Humean scepticism about them as unwarranted.[236]

There is, however also an *epistemic* dimension to Hume's observation. If we cannot observe the causal relations between particulars, how can we – granted that they do exist – obtain knowledge of their existence in a *particular case*? Gasking's example, and the metaphysical/epistemological argument that can be based upon it, implies only that *some* singular sequences can be perceived. It does not imply, or even suggest, that *all* or even *most* of them can. Even if there are situations in which we seem able to observe a causal sequence between particulars, it is clear that we are often not able to do so. Whereas in Gasking's example, both cause and effect are salient events adjacently occurring in time and space in the relative absence of other events, most natural courses of events will take place in much more obscure contexts. If the causal relata of interest do not stand out as sharply against other facts or events, the

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[235] Quoted in David Armstrong, *What is a Law of Nature?*, 1983, p. 93.
[236] See, for example, Cartwright, "Capacities and Abstractions", 1989, pp. 349 ff.

observation of singular causal sequences will be difficult, and such observation seems to presuppose some prior causal knowledge.

Indeed it is in complex scenarios like these that the need for some prior scientific causal knowledge to make causal judgments seems to be the greatest. Hume's point, that knowledge of regularity *always* is needed may be false. However, it seems that some additional knowledge of regularities, or some other relation, is *often* needed to make causal judgments about singular sequences. And if it is, two questions arise – about how such knowledge can be obtained, and about how it relates to the singular sequences to be inferred in scientific as well as legal contexts. The first of these questions will be discussed in the following sections in this chapter; consideration of the second will be postponed until Chapters 5 and 6.

4.4.2 Isolated Relations and Relations in Groups

In its pursuit of knowledge of the world's causal structure science has devised certain strategies. One obvious and commonly employed strategy is to physically isolate potential causes in a laboratory. The complex nature in which that kind of entity may otherwise occur is thus to a large extent locked out, and so are many of the factors that could have affected the occurrence of the potential effect. Because other potentially relevant factors are excluded, changes in the relevant effect can be referred to manipulations of the relevant cause.

Another strategy is to compare groups of scenarios. For example, a group in which the potential cause is present (a "test group") can be compared with a group in which it is absent (a "control group") in a so-called cohort study.[237] Suppose we are

[237] Group studies can be designed and run in various ways. Instead of comparing groups in which the potential cause is present and absent, groups in which the effect is present and absent can be compared in so called case-control studies, see, for example, Fletcher and Fletcher, *Clinical Epidemiology*, 2005, pp. 75 ff. See also Ford, *Scientific Method for*

interested in knowing whether smoking really causes lung cancer. If so, we can compare the incidence of lung cancer in a group of smokers with its incidence in a group of non-smokers. If the presence of other causally relevant factors (exposure to asbestos, radon, and so on) is the same in the two groups, an increased occurrence of lung cancer in the test group can be ascribed to the smoking.[238]

Now, these two strategies do not merely work as tools that enable us to acquire knowledge of causal relations. They also affect *what* relations will be known. The first, isolation strategy generates knowledge of a causal relation which sets in when other factors are excluded. Many conditions which might have been present in a natural context are thus artificially and collectively excluded from the experimental situation. The first strategy therefore allows for knowledge of relations that hold in *isolated* contexts.[239]

The second strategy may (but need not) be applied to natural contexts. As was said above, this strategy is used to study the difference a potential cause makes in a group by, for example, comparing the outcome in a test-group in which the cause is present with the outcome in a control-group in which it is absent.[240] The result obtained will depend (supervene) on what happens to the groups' individual members. However, the strategy will not generate direct knowledge of the relation between the cause and the

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Ecological Research, 2000, pp. 159 ff. on the relevance of group studies in ecology.

[238] For discussion of additional difficulties involved in ensuring that the groups really are equivalent and in the making of inferences about populations on the basis of group data, see, for example, Morgan and Henrion, *Uncertainty*, 1992, pp. 56 ff. Some of the strategies or standards that science has adopted in dealing with these difficulties risk being inappropriate in a legal context due to the epistemological differences between law and science (see Section 1.2.1 above).

[239] Here, the laboratory works as what Cartwright has called a "nomological machine" (Cartwright, *The Dappled World*, 1999, pp. 49 ff.).

[240] Cf. note 237 above.

effect in any of these members. It will simply generate knowledge of the relation between the cause and the effect in the *group* as such.

To see this more clearly, consider the kind of information this latter study provides. Normally, this will be information about the relative frequencies of the effect in the test groups as compared to the control groups. The individual members of the test group will normally differ from each other in an infinite number of ways, many of which may be relevant to the occurrence of the effect.[241] For example, even a factor like smoking, which is regarded as a very powerful cause of lung cancer, is insufficiently powerful to lead to lung cancer in each and every smoker. Genetic constitution, vegetable intake, exercise habits and radon and asbestos exposure are only some of factors that may be relevant to its prospects of doing so.

Just as a particular person's smoking will not necessarily give rise to lung cancer, a particular person's lung cancer will not necessarily be due to smoking. Like many other phenomena of human interest, lung cancer may be caused in several different ways, and not all of these involve smoking. For example, radon and asbestos, both of which are synergistic with smoking in causing lung cancer, can also cause lung cancer without a contribution from smoking.[242] In the example just mentioned, some members of the non-smoking control group may therefore be found to have developed the disease, too. Furthermore, these and/or other alternative factors which are unrelated to smoking may also be solely responsible for some cases of lung cancer among the smokers in the test group. Even if a significantly higher frequency of lung cancer is observed in the test group, this does thus not guarantee that a particular occurrence of lung cancer in one of its members was the

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[241] Worldly indeterminism is another possible reason for the less than perfect correlation between cause and effect among the members of a group. Since individual variability will presumably be more important to the causal relations of relevance in a legal context than indeterminism is, I will disregard this possibility.

[242] Baird and Cann, *Environmental Chemistry*, 2008, pp. 170 f. and 376 f.

result of smoking. What we will end up knowing is merely how much more frequent the effect is when the cause is present in a *group* of this kind. Because an individual member of the group will be unique in several causally relevant ways, and differ in those ways from the merely hypothetical "average group member", the frequency obtained is not a property of any of its actual individual members.[243]

Both the kinds of study are able to take more conditions than the cause into account. For example, the members of the groups in a group study may all resemble each other in one or several causally relevant respects. Thus, we can get information about the relation between radon exposure and lung cancer among smokers by looking at the difference that radon exposure has in a group of smokers. Analogously, we can obtain information about the relation between radon exposure and lung cancer among male smokers by looking at the difference such exposure makes in a group of male smokers. However, there are limits to this strategy. Each new study will involve additional costs. The societal value of very detailed knowledge of the effects that radon exposure has on male vegetarian smokers, say, need not be much greater than that of knowledge of the effects that radon exposure has on smokers. Given this, such studies are not automatically justified, economically speaking. In addition, factors of relevance for the relation between radon exposure and lung cancer may occur in an infinite number of combinations. It is obvious that scientific studies of all of these combinations are not practically feasible. Furthermore, taking more than a limited number of factors into account will require sufficiently many sufficiently similar people to be found. The more factors that are taken into account, the more difficult this will be. In reality, the scientific knowledge of the interaction of causally relevant factors is very limited and will generally include at most a few factors of

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[243] This point has been used as an argument against applying probabilities to anything other than groups or repeatable events (Von Mises, *Probability, Statistics and Truth*, 1981 (1957), p. 11).

relevance to the existence of a causal relation between particulars in a natural context.[244]

Scientific knowledge of relations that occur in isolation and in groups is necessarily fragmentary. A large number of factors are potentially relevant to the relations that obtain between entities of the same kind. Not only is it difficult and resource-intensive to obtain knowledge of the detailed contribution of a large number of factors; these factors can be combined in a practically endless number of ways and the majority of the relations that occur in these combinations will remain unknown. Moreover, some types of relation will be impossible, or at least very difficult, to detect by means of these strategies. Isolation studies will by definition fail to detect relations that can occur as a result of the complex contribution of a large number of factors in a natural context. Cohort studies will typically fail to detect rare effects.[245] Many relations with long latency periods, such as the relations between exposure to toxic substances and cancers, are likewise difficult to assess in a controlled study. Both strategies can also be inapplicable for moral reasons. Thus, there are significant moral problems involved in putting human beings in long-term isolation – or in deliberately exposing

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[244] Parascandola, "What is Wrong with the Probability of Causation?", 1998, p. 35 .

[245] Fletcher and Fletcher, *Clinical Epidemiology*, 2005, p. 84. Hansson speaks of an "ethical gap" between risk levels that are scientifically detectable and those that are ethically acceptable. (Hansson, "Philosophical Perspectives on Risk", 2004, pp. 19 f.) It can be noted that large effects are not only easier to detect but often seen as an indication that the underlying relation is real (Hill, "The Environment and Disease", 1965, pp. 295 f.). The results of studies in which only small effects have been detected are therefore often more difficult to publish and hence less likely to be accepted by the scientific community. According to Marcia Angell, former editor of New England Journal of Medicine, "we are looking for a relative risk of three or more [before accepting a paper for publication], particularly if it is biologically implausible or if it is a brand new finding" (quoted in Taubes, "Epidemiology Faces its Limits", 1995, p. 168).

such beings to potentially harmful factors.[246] Many relations between potential causes and effects which are not easily disclosed by these strategies will thus remain unknown. Moreover, the disciplinary division of science into microbiology, biochemistry, epigenetic, epidemiology, limnology, eco-toxicology, conservation biology, and so on, places a contingent, yet important, constraint on what kinds of causal relation the scientific knowledge is about. For example, the impact of chemicals on ecosystems fell outside the working areas of both toxicology and ecology, and thus was not studied by any scientific discipline until the rise of eco-toxicology in the 1970s.[247] Clearly, however, chemicals had effects on ecosystems before that.

4.4.3 Isolated Relations, Relations in Groups and "True" Causation

Much scientific knowledge of causation, then, concerns relations that occur in isolation and/or in groups. These relations fall into *two distinct kinds* (though some of their instances, such as relations detected in laboratory tests on groups of animals, will coincide.) At this point, it will probably be objected that all scientific knowledge is about the same kind of causal relation. The differences just mentioned arise merely because these relations can be manifested in different ways as a result of the strategies that we are obliged to adopt to detect them.[248] For example, some scientists would say that

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[246] See the discussion in Sahlin and Persson, "Epistemic Risk", 1994, p. 51. Often, therefore, the moral and temporal constraints involved in tests on human beings mean that fully randomized cohort studies cannot be performed. Instead more uncertain, retrospective, case control studies must be relied on. (Hennekens and Buring, *Epidemiology in Medicine,* 1987, p. 150.)

[247] Truhault, "Ecotoxicology", 1977, pp. 151 ff.

[248] See the criticism in Parascandola and Weed, "Causation in Epidemiology", 2001, p. 909, of the confusion between the criteria defining a cause, which is an ontological matter, and the criteria identifying a cause empirically, which is an epistemological matter.

it is the biffs, or the NESS-relations, discussed in Chapter 3 that constitute the *real* causal relations that science is interested in knowing.[249] They will admit that some such relations will occur in isolation contexts, too, and hence will be easier to obtain knowledge of. Similarly, they will admit that such relations may give rise to observable distributions in studied groups. However, they will deny that the relations that occur in isolation belong to a particular kind of causal relation and that the distributions that can be observed in groups qualify as causal relations in themselves.

This counter-argument accords with the idea that scientific explanation of phenomena involves the discovery of underlying causes.[250] These underlying causes, and the *mechanisms* by which they operate, are often seen as more fundamental than, and able to explain, the observed association between a cause and effect in a group study.[251] Thus, it is often said that an understanding of the process through which these underlying causes give rise to an observed association is necessary to warrant a conclusion that the association is genuinely causal.[252] Such an understanding will indicate the existence of a "real" causal relation between the cause and effect at issue, which can therefore be seen as responsible for, for example, an observed higher frequency of the effect in the group which has been exposed to the cause.

I have no objections to this analysis of the proper understanding of causality in science. However, I do not think that it is immediately relevant to the issue at stake here, which concerns how differences between the entities treated in legal questions and scientific information impede the answering of the former. Even if the

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[249] See, for example, Bogen, "Regularities and Causality", 2005, pp. 399 ff. and Stapleton "Scientific and Legal Approaches to Causation", 2002, pp. 15 ff.

[250] See Section 4.3 above.

[251] See, for example, Machamer et al., "Thinking about Mechanisms", 2000, p. 21.

[252] Hacking, *Representing and Intervening*, 1983, p. 35. Cf. Hill, "The Environment and Disease", 1965, p. 298.

scientifically known relations can be analyzed or explained by reference to a biff, or a NESS, this does not imply that this analysis accounts for the only causal categorization that is scientifically relevant, or even for the categorization that is of most interest for present purposes. As we have seen, isolation studies are an important means of obtaining scientific knowledge of causation. Relations that occur in isolation are therefore a kind of entity upon which science deliberately directs much of its focus. The reason for this focus is epistemic, but the entities on which the focus is directed are real, and the recognition of this category is methodologically fruitful.[253] Similarly, group studies are an important means of acquiring scientific knowledge of causation. Even if observed distributions in groups can be explained in terms of some underlying "real" causal relations, and even if the reason for the scientific focus on them is partly epistemic, the distributions themselves exist too.[254] Distributions in groups are therefore also a scientifically important and recognized kind of entity – one with a role to play in the scientific enterprise of explaining the world.

It should be observed that although language, as discussed in Chapter 2, is an important guide to the kinds of entity that are relevant within a theoretical framework, the assignment of a label is not a necessary condition for an entity's relevance within such a framework. Scientific experiments indicate that relations that occur in isolation or in groups are scientifically relevant, irrespective of whether any particular term is used to refer to them. Relations that

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[253] It can be noted that scientifically known mechanisms, too, are often theoretically isolated in time and space. For example, descriptions of mechanisms are often said to include *idealized* descriptions of the start or set-up conditions. (Machamer et al. "Thinking about mechanisms", 2000, pp. 11 ff.) Idealized descriptions of the start or set-up conditions mean that antecedent factors of relevance to the beginning of the process are excluded, as normally are many factors that could subsequently have intervened to stop or change the process. In addition, many scientifically known mechanisms will stretch across very limited time spans.

[254] At least in the "mildly realistic" sense discussed in Section 1.2.2 note 25.

occur in isolation and relations that occur in groups can thus both be characterized as real and scientifically recognized kinds of relation which, in this investigation, can be fruitfully contrasted with the kind of relation that the two legal questions investigate. Whether, and if so how, these scientifically known relations are accorded the status of "causal" in a deeper metaphysical analysis is of less interest in this context. What is important is rather that scientific knowledge of them often provides non-redundant information about the causal relations examined in a legal context. In this monograph, this suffices to make it appropriate to refer to these entities as scientifically known "causal relations".

4.4.4 Isolated Relations, Relations in Groups and the Scope of Scientific Knowledge

The discussion I present in later chapters, about the possibility of establishing legally relevant relations through the application of scientific information, will be concerned primarily with scientifically known relations that occur in isolation and/or in groups. It may be felt that this restricted focus involves an artificial and rather narrow delimitation of the scope of scientific knowledge. Thus, it is often said to be characteristic of scientific knowledge that it applies in contexts other than those in which it was obtained.[255] Consequently, knowledge obtained by means of studies undertaken in isolation and/or on groups is assumed to apply to other relevantly similar situations, too, and can therefore be used to make inferences about, say, relations between particulars in natural contexts as well.

The notion of "relevant similarity" here introduces an important limit to the scope of scientific knowledge. This limit is often registered in an implicit or explicit *ceteris paribus* clause (literally meaning "other things being equal"), which is attached to the

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[255] See, for example, Ashby, *An Introduction to Cybernetics*, 1957 (1956), p. 121, Feynman, *The Character of Physical Law*, 1992 (1965), p. 164 and Mitchell, *Biological Complexity and Integrative Pluralism*, 2003, p. 133.

scientifically known "law" or relation. [256] To determine whether this knowledge is applicable in a certain situation requires an assessment of the knowledge, including the situation in which it was obtained *and* the situation to which it potentially applies. This kind of assessment is made in many scientific contexts, and its outcomes, which are reached by means of applicable scientific standards or proof, can therefore themselves be seen as parts of scientific knowledge.[257] As will be discussed at length below, this kind of assessment is relevant in many legal contexts, where it is used to establish legally relevant relations. There, however, it ought to be made according to legal standards of proof.[258] In a study like the present one, which investigates the possibility of establishing legally relevant relations through the application of scientific information and legal standards of proof, it is therefore appropriate to separate the process in which scientific knowledge is applied from that through which it is obtained. In this monograph, the legally relevant relations will therefore be contrasted mainly with the originally scientifically known relations, which to a large extent are relations that occur in isolation or in groups.[259]

It should be clear, then, that in focusing the discussion on scientifically known relations that occur in isolation or in groups I do not wish to deny that causal relations between particulars in natural contexts are often both scientifically known and relevant. Some of these relations – like that between the "dropping of the stuff" and the explosion described in Gasking's example – can perhaps be established without the aid of knowledge of relations that occur in

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[256] See, for example, Cartwright, *How the Laws of Physics Lie*, 1983, pp. 44 ff. and Mitchell, *Biological Complexity and Integrative Pluralism*, 2003, pp. 163 ff.

[257] In Sections 1.2.3 and 4.2 above, scientific knowledge was characterized as the outcome of scientific standards of proof. See also note 18.

[258] See the discussion of the epistemological differences between law and science, and of the priority of the legal standards of proof, in Section 1.2.1 above.

[259] See also Section 5.3.2.

isolation or in groups, and can perhaps be extrapolated to other situations by means of analogical reasoning. [260] However, many scientifically relevant singular sequences are of a less salient character, and their establishment will often have to rely, to some extent, on scientific knowledge obtained by means of isolation or group studies. (I note in passing that Gasking's example is set in a laboratory.) Hence the scientific relevance of some relations between particulars in natural contexts, and our possession of knowledge of those relations, does not alter the fact that establishing legally relevant causal relations via scientific knowledge is a process that has to reply to a large extent on scientific knowledge of relations that occur in isolation or in groups. (Besides, and as we shall see below, the difficulties involved in establishing a legally relevant relation through the application of scientific information are similar, whether the scientifically known relation occurs in isolation, in groups, or between particulars in a natural context.)

4.5 Conclusions

In this chapter I have characterized scientifically known causes, effects and causal relations. One factor which was said to be of particular importance in the scientific distinction between different kinds of entity was the causal heterogeneity of these entities with respect to the effects of interest in a certain scientific context. Different disciplines, with their different interests, recognize distinct kinds, at different levels of granularity and with different explanatory roles. The scientific flora of causal relata is thus very rich. Many of these kinds will be at least partly overlapping, but very few of them are likely to be explanatorily redundant. Even so, the kinds that are at present recognized by science can only be expected

[260] See, for example, Shrader-Frechette and McCoy, *Method in Ecology*, 1993, p. 131 ff, for discussion of the ecological relevance of singular causal sequences and analogical reasoning.

to account for part of the causal relevance of the world that science aims to explain. To acquire knowledge of causal relations between these kinds, science makes use of certain strategies. As we have seen, these strategies not only make knowledge of causal relations possible, but also help to determine which causal relations, precisely, become known. Many of the scientifically known relations are relations that occur in isolation or in groups. Like scientific knowledge of the causally relevant elements of the world, scientific knowledge of these relations is necessarily fragmentary.

5 Ontological Differences

5.1 Introduction

In this chapter, I will compare entities of legal and scientific relevance on the basis of the characterizations of these entities given in Chapters 3 and 4. Section 5.2 compares factors of relevance to the demarcation of legal and scientific causes and effects and discusses how they relate to each other. Section 5.3 contains a corresponding discussion of legally relevant and scientifically known causal relations. Section 5.4 summarizes the chapter's most important conclusions.

5.2 Legal and Scientific Causes and Effects

5.2.1 Factors of Relevance to the Demarcation of Legal and Scientific Causes and Effects

In Chapter 3, we saw that many (but not all) legal rules that serve to counteract detrimental consequences of human behaviour impose a responsibility to counteract effects caused by the particular behaviour for which a person can be held responsible (often the behaviour of the person himself). Many of these rules thus require there to be a causal relation between the particular behaviour and the particular damage to be counteracted: this connection is needed

if counteractive responsibility is to be prescribed. The responsibility that these rules impose is either rectificatory or preventive, and the causal relation is established either retrospectively or prospectively. When applied, the rules raise the question "Did this behaviour cause the damage", or "What damage (if any) will this behaviour cause?"

The rules at issue here have in common that the *legally* relevant causes consist in human behaviour. This link between human behaviour and legally relevant causes is not necessary, but it is both common and natural: human behaviour is well known to give rise to a large number of detrimental consequences and the character of human behaviour is relevant in justifying the *imposition of counteractive responsibility*. Just *what* behaviour is relevant depends, as we have seen, on the rules in question and on considerations relevant to the kind of responsibility being imposed. Normally, therefore, behaviour that is relevant according to one particular rule will not be the only sort of behaviour whose consequences the law aims to counteract. Considerations that are of importance in this respect pertain to morality, predictability, efficiency, economy, and so on. Suspected detrimental capacity is certainly one factor of potential relevance to such considerations. Thus, if some kind of behaviour is supposed to have detrimental consequences, this may contribute to a legal classification of it as negligent, or to an application of strict liability for its consequences. However, the detrimental potential of the behaviour is only one of a *number* of factors of legal importance. Other factors that are relevant in this respect might include the state of knowledge of the person at the time of the behaviour, the behaviour's societal acceptance and utility, the costs of preventive measures, and so on. The behaviours that are relevant to a particular rule will emerge as sufficiently homogeneous in the light of all legally relevant considerations to warrant being associated with the same kind of responsibility. Hence behaviours that are in this way homogeneous will constitute legally relevant kinds of entity and cause when questions about the application of the rule arise.

The mechanisms that determine what constitutes a legally relevant effect are basically the same as those that determine what constitutes a legally relevant cause. All of the effects of relevance in

the two questions have in common the fact that they threaten legally recognized interests. As discussed in Chapter 3, many of these effects are consequences of a kind that the law is ultimately designed to counteract: they involve *intrinsic* damage. Others do not qualify as intrinsic damage in their own right but can be assigned the legal status of effects that should nevertheless be counteracted for instrumental reasons: these involve *absolute instrumental* damage.[261] Just what effects are relevant, given a particular rule, will likewise depend on a number of considerations. As we have seen in Chapter 3, these considerations differ from one rule to another, depending on, for example, the burden of the counteractive responsibility that the particular rule imposes and the interest that it is used to protect. Thus, tort law is generally concerned with the interests of co-existing persons, whereas environmental law, with its aim of promoting sustainability, also serves the interests of future generations.[262] Furthermore, it is possible to interpret the Environmental Code as serving certain non-anthropocentric interests. At present, tort rules, on the other hand – even those in the Environmental Code – can hardly be conceived of as serving to protect non-human interests.[263] At the same time, the environmental focus excludes some effects (e.g. offences) of relevance to regular tort law from the scope of

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[261] The distinction between intrinsic damage and absolute instrumental damage is elaborated in Section 3.3.2.

[262] See, for example, Westerlund, who speaks about the traditional horizontal/synchronic, as opposed to environmental vertical/diachronic, dimensions of the regulation (*Miljörättsliga grundfrågor 2.0*, 2003, pp. 23 f. and p. 261, *Fundamentals of Environmental Law Methodology*, unpublished, pp. 79 ff.).

[263] NJA 1995 p. 249 (discussed in Chapter 2) is normally regarded as a case of damage to the state. The protection of non-human interests is a matter both of whether these interests should be legally recognized (see Section 3.3.2 above) and whether there are legal means to represent them (see Lindblom, *Miljöprocess I*, 2001, p. 88 and Stone, *Should Trees have Legal Standing?*, 1974).

environmental regulation.[264] It can be seen, then, that the effects that are relevant, given a particular legal rule, will generally not exhaust the effects that the law aims to counteract.

The demarcation of *scientifically* relevant causes and effects, on the other hand, is relative to the scientific aim to *reveal the causal structure* of the world, rather than to the imposition of responsibility in a legally appropriate way. Consequently, and as discussed in Chapter 4, causal heterogeneity is an important ground for discrimination between causes and effects in science. To a large extent, therefore, assumed causal homogeneity will determine the demarcation of scientifically relevant kinds; and conversely homogeneity with respect to legally relevant considerations relating to the rule of law, morality, economy, and the like, is practically irrelevant to scientific categorizations. As seen in Chapter 4, causal homogeneity will often be found on a smaller scale, and thus so will many scientifically relevant causes and effects. Much scientific explanation thus involves the decomposition of phenomena into their underlying causally efficient components. Even so, many observable patterns – as the result of practical, and perhaps also theoretical, obstacles – are not explainable in terms of these micro-level entities.[265] Many of the scientific theories and explanations are therefore instead stated in terms of macro-level kinds of entity, such as different kinds of clouds, species, predictive and competitive effects, and so on. Things of these kinds, such as the individual members of a species, are normally known to be causally heterogeneous in many respects. Yet, they are sufficiently homogeneous in relation to the patterns that they are taken to explain to motivate the notion that they are affiliated to the same kind with respect to that explanatory purpose. Causal homogeneity is thus a factor of relevance to the demarcation of these macroscopic kinds, too, although it is balanced against practical explanatory fruitfulness.

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[264] Cf. chap. 2 sec. 3, Tort Liability Act, and chap. 32, Environmental Code. See also Section 3.3.2.

[265] See the discussion in Section 1.2.2, note 25 and Section 4.2.

In contrast, human behaviour is often less important to scientific categorizations than it is to the delineation of legal categories. Admittedly, some scientific enquiries are explicitly directed upon the effects of human behaviour. An example of such a scientific enquiry, and one of considerable current interest, concerns the extent to which anthropogenic emissions of greenhouse gases affect climate. Yet, the kinds of entity that scientific knowledge is about are often not demarcated according to the boundaries of human behaviour, notwithstanding the fact that that such information sometimes is applied, and used, to answer questions about the effects of such behaviour.[266] Thus, some instances of scientific causes and effects, including greenhouse gases and climate change, will overlap with, or form part of, human behaviour and its effects, but others will not. The fact that these scientific causes are merely contingently correlated to human behaviour will not detract from their scientific interest; human behaviour is often not a criterion for distinction in the causal structure of the world that science seeks to establish.

This is not to deny that human behaviour and values are generally highly relevant to the question what causes and effects are scientifically *known*. The societal (including legal) value of our knowledge of the effects of human behaviour certainly may – intellectually and/or economically – attract scientific attention. The discovery of highly beneficial or detrimental effects tends to draw more attention from the scientific community and its financers than the discovery of effects of no known value. Hence human behaviour and underlying values may have a significant effect on what studies are being conducted, and consequently on what causes and effects we possess scientific understanding of. Likewise, the scientific standard of proof which, as discussed in Chapter 1, often is a function of cognitive values, will determine what conclusions can be drawn from particular studies, and hence what qualifies as scientific knowledge.

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[266] This is a generalization. In some scientific contexts within (say) medical science, human behaviour might be important to the demarcation of scientifically relevant kinds too.

5.2.2 Relations between Legal and Scientific Causes and Effects

Many of the moral, economic and other considerations that are relevant to the demarcation of legally relevant behaviour apply at the level of ordinary life at which the behaviour is directed and can be recognized. As a result, many legally relevant causes are rather large entities with relatively wide extension in space and time. It is to such entities that the retrospective and prospective legal questions about causation apply. Whether the causal relation to which such a question draws attention exists depends on the behaviour's causal capacity with respect to the legally relevant effect. Science assists in the answering of these questions on the basis of the scientific kinds of causally relevant entities that the behaviour is known to instantiate and the relations that are known to hold between these kinds and the kinds instantiated by the legal effect.

As seen already, the scientific knowledge includes a rich flora of distinct causally relevant kinds at different levels (and hence differing in scale). Although entities at different levels may spatially overlap, these entities are used to explain different aspects of the world and many of the relations that can be scientifically established at one level cannot be established at the other.[267] Consequently, a single legal cause can instantiate a number of scientific kinds of entity at different levels – kinds that are themselves spatially overlapping, yet far from being explanatorily redundant. This relation between legal causes and scientific entities holds already for relatively small legal causes. Thus, a particular negligent behaviour (which is a more circumscribed cause than, say, an activity that also includes non-negligent behaviour) will typically instantiate a number of distinct scientific kinds. Consider, as an example, a negligent behaviour consisting in the discharge of waste water without adequate preventive measures. This discharge may involve various viruses, chemical compounds, and bacteria. Legally relevant

[267] See Section 1.2.2 note 25 and Section 4.3.

causes that are not restricted to negligent behaviour will typically include even more scientific kinds. For example, a legally relevant industrial activity may (in addition to the discharge of waste water) involve the emission of various oxides, the devastation of forested land, excavations, the removal of water, and so forth.

Already, then, a particular instance (*individual*) of a legally relevant cause will often embody a conjunction of instances of distinct scientific kinds. As indicated in Chapter 2, the relation between legal and scientific categorizations becomes even more complex if we instead look at the relation between the *kinds* that law and science recognize.[268] Negligent behaviour does not only involve discharges of wastewater; it may also involve, *inter alia*, the usage of a particular biocide, or radioactive equipment, or poorly tested drug. Legally relevant kinds of entity will thus typically include a disjunction of conjunctions of instances of distinct scientific kinds.[269] Given that each of these legal kinds only reflects part of the behaviour whose consequences the law aims to counteract, it becomes obvious that this latter behaviour instantiates a good number of distinct scientific kinds. Scientific entities can thus be conceived of as (causally relevant) *parts*, both of the particular legally relevant causes, and of the entire class of human behaviour whose consequences the law aims to counteract.[270]

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[268] Section 2.4.

[269] As seen in Section 2.4, relations of these types hold between many scientific kinds too.

[270] There are potential differences between the relevant contrasts too. (For a philosophical discussion of the relevance of contrasts to causal questions, see, for example, Hitchcock, "The Role of Contrast in Causal and Explanatory Claims", 1996, pp. 395 ff.) If the behaviour is negligent because one chemical substance is used instead of another, less dangerous one (see, for example, the substitution rule in chap. 2 sec. 4, Environmental Code), the legally relevant contrast consists in the usage of a, or several, less dangerous substances, while the scientifically relevant contrast consists in the absence of the substance actually used. Unfortunately, I am unable to explore the epistemic difficulties associated with these differences more thoroughly in this monograph.

The effects to which the two legal questions draw attention can include a number of scientifically relevant entities, too. This – at least, in theory – is true already of the particular effects of relevance in the retrospective question. For example, what, in a legal context, is regarded as a case of fish death, may – also in a particular case – involve a number of distinct scientific kinds of entity, including reduced reproduction, death by starvation, death by suffocation, and so on. Similarly, a personal injury or disability may involve a number of different medical conditions. In practice, however, the effect of relevance in the retrospective question will often be ostensively identified – and thereby demarcated – in scientific terms. Thus, for instance, it may be asked whether a particular behaviour caused a particular medical condition. This will naturally limit the scientific complexity of the effect that a certain retrospective question is about. The prospective question, however, is not restricted to an ostensively identified effect that has occurred; it is a question about the entire legally relevant effect of a particular behaviour. This effect will typically instantiate several distinct scientific kinds of entity. Even more importantly, the *kinds* of effect that are relevant according to particular rules, regardless of whether these rules give rise to retrospective or prospective questions, will involve large numbers of scientific kinds. So, *a fortiori*, will the kinds of consequences of human behaviour that the law aims to counteract.

It is important to see that a legally relevant entity cannot be identified with its scientifically known elements. The fact that scientific information about a legal cause's causally relevant parts is relevant in a legal question about causation does not imply that the legally relevant cause is identical to its scientifically known parts. The boundary of the legally relevant cause is still a function of legally relevant considerations. A discharge of waste-water which qualifies as negligent behaviour will do so *qua* careless discharge of waste water and irrespective of what faecal streptococci, chemical compounds and other causally relevant features it is known to have. The same is true of the legally relevant effect. As discussed in Chapter 4, the ongoing discovery of new causally relevant kinds suggests that our scientific knowledge of such kinds is fragmentary. The present scientific map of the world's causally relevant kinds is

thus presumably far from complete; so too, presumably, are the causal tables of contents of the legally relevant entities that science can provide. Consequently: legally relevant causes and effects will contain scientific entities as parts, but these parts will typically not exhaust the causal capacity of the legal entities.

5.3 Legal and Scientific Causal Relations

5.3.1 Factors of Relevance to the Demarcation of Legal and Scientific Relations

The two legal questions "Did this behaviour cause the damage?" and "What damage (if any) will this behaviour cause?" arise in the application of legal rules that impose responsibility to counteract consequences of human behaviour. Both these questions focus on relations between the *particular* behaviour for which a person can be held responsible and some *particular* damage that is to be counteracted. These legally relevant causes and effects occur in a *natural context* (i.e. not in an isolated laboratory setting) where they often are separated by relatively large intervals of time and space.[271]

The existence of a causal relation between the particular damage and particular behaviour for which a person can be held responsible is often regarded as relevant to the moral justification of the imposition of responsibility to counteract the damage.[272] This kind of moral justification is predominantly discussed in connection with rules that impose a responsibility to compensate others for damage that has already occurred. However, similar considerations are probably relevant to the scope of rules that impose responsibility to,

[271] See Section 3.3.3.
[272] See Section 3.3.3.

for example, put in place preventive measures. In addition, the existence of a relation between particular behaviour and damage is of relevance to the accuracy of the imposed preventive measures. Thus, if such responsibility is imposed irrespective of whether a causal relation between the behaviour and damage exists in the particular case, there is a risk that this responsibility will be excessively or insufficiently far-reaching in the circumstances of the case. Even so, we have seen in Chapter 3 that, so far as the counteractive responsibility they impose is concerned, many legal rules do not require there to be a causal relation between particular behaviour and particular damage. Instead, they impose preventive responsibility on the basis of an established association between *kinds* of behaviour and *kinds* of damage. Considerations that favour the requirement of a relation between particulars will sometimes, therefore, have to give way to other legally relevant considerations – e.g. considerations pertaining to economic regulation and general efficiency.[273] Either way, the ensuing requirement is a result of balancing consideration of relevance to the kind of responsibility that the rule imposes and to the aim that the rule serves. Here I am interested chiefly in rules that *do* require a causal relation between particular behaviour and damage.

In a natural context many factors other than the potential cause may work in such a way as to counteract, or contribute to, the occurrence of a particular effect. As discussed in Chapter 3, most interpretations of the causal relation which, according to several legal rules, must hold between a particular behaviour and damage will, in one way or another, take the contribution to, or counteraction of, such factors into account. On most legal interpretations of causation, the absence or presence of a large number of other causally relevant conditions is therefore relevant to the existence of a legally relevant relation between a particular behaviour and damage. Hence knowledge of such conditions is relevant to questions about these relations.

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[273] See the discussion in Section 3.2.2 above.

As discussed in Chapter 4, it is notoriously difficult to obtain direct and detailed understanding of causal relations between particulars in a natural context. Science, however, uses certain strategies to facilitate the acquisition of causal information. These strategies allow causal relations to be established even when only a few causally relevant factors are explicitly taken into account. As seen in Chapter 4, one such strategy is to study a cause and its effects in relative isolation, where many other potentially relevant factors are artificially blocked out and hence known to be absent. Another strategy, which is often combined with the first, is to study the relation between causes and effects in a group, where the effects of other potentially relevant factors can be expected to even out. These strategies not only make knowledge of causation possible; they also affect what causal relations are scientifically known. As a result, many scientifically known relations are relations that occur in isolation or between groups.

These scientific strategies have been adopted partly in response to epistemic obstacles to the establishment of causal relations between particulars in natural contexts. Moreover, legally relevant considerations (e.g. pertaining to moral justifiability and the accuracy of the rule's aim) that tend to favour the relevance of relations between particulars are relatively unimportant in science, where the aim is to explain rather than to promote some kind of justice. It can be seen, then, that relations between particulars are often of relatively little scientific interest in themselves.[274] Studies of the more detailed contribution of various factors require additional resources, and the added efforts that need to be made to develop scientific knowledge of this sort will often simply not be worthwhile.[275] In the law, on the other hand, where these other non-

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[274] It is another matter that these relations often are relevant in other – i.e. non-legal – *applications* of science, too. (See Section 1.2.1 note 18.)

[275] Of course, there are scientific contexts in which knowledge of the relations between particulars is relevant as well. See, for example, Shrader-Frechette and McCoy in *Method in Ecology*, 1993, pp. 131 ff. on the

cognitive considerations are highly relevant, considerations tied up with the epistemic constraints involved in the establishment of causal relations have generally had less influence than they have in science.

5.3.2 Relations between Legal and Scientific Causal Relations

I have argued that whereas the two legal questions draw our attention to relations between particulars in natural contexts, many relations that are scientifically known occur in isolation or between groups. Hence, these legal and scientific relations seem to be of different kinds. As was discussed in Chapter 4, some scientists and philosophers would presumably deny that "relations that occur in isolation" or "distributions in groups" qualify as kinds of causal relation.[276] Even so, these isolated relations and distributions exist in the world and the "kinds" to which they can be referred are scientifically important categories. Moreover, knowledge of them will often provide non-redundant – if sometimes insufficient – information about legally relevant relations. In this monograph they can therefore be appropriately conceived of as kinds of causal relation.

Legally relevant relations that hold between particulars in a natural context will generally fail to coincide with relations that occur in isolation or hold in groups. Hence it may seem that the legal questions seek relations *other* than those that science provides information about. However, a familiar aspect of science may be taken to suggest that this conclusion is premature. As mentioned already in Chapter 4, it is often pointed out that the utility of scientific information is associated with its validity in contexts other

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particularistic nature of much ecological knowledge and the discussion in Section 1.2.3 and Section 4.4.4 above.

[276] Section 4.4.3.

than those in which the information was derived:[277] *general validity* is seen as a fundamental characteristic of scientific knowledge. However, as also indicated in Chapter 4, it is widely acknowledged that scientific knowledge is valid only *ceteris paribus* – that is, only in circumstances that are relevantly similar to the context in which the information was developed. The *ceteris paribus* clause here obviously introduces a limitation, so something more should be said about how this clause relates to general validity.

The general validity of scientific information may in itself seem to imply that scientifically known relations somehow include the legal relations too. Thus, it may seem to suggest that scientifically known relations obtain at a higher level of abstraction, and that the legally relevant relations are objects of generally valid scientific knowledge.[278] In order to see what the general validity of scientific information really means in this respect, it is useful to distinguish between different degrees of generality. Simply put, general validity will typically imply that knowledge of a relation between two particular entities or groups of entities (a_1 and b_1) is valid for the kinds (*A* and *B)* to which these particulars belong. (I use upper-case letters to refer to kinds and corresponding lower-case letters to refer to their instances.) With an extensive interpretation, this implies that the knowledge is valid for *all instances* of *A* and *B* (i.e. for all *a*s and *b*s). On a more restrictive interpretation, it implies that the knowledge is valid for *sufficiently similar instances* of *A* and *B*. Extensive validity is typically regarded as a scientific virtue[279]

Scientific information can be, and often is, expressed in rather general terms. Thus, if it is known that some *a* has caused some *b*, it is also correct to say that it is known that *A* causes *B* (because it does

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[277] Section 4.4.4. See, for example, Ashby, *An Introduction to Cybernetics*, 1957 (1956), p. 121, Feynman, *The Character of Physical Law*, 1992 (1965), p. 164 and Mitchell, *Biological Complexity and Integrative Pluralism*, 2003, p. 133.

[278] Cf. Cartwright, "Capacities and Abstractions", 1989, p. 354.

[279] Cf. Mitchell, *Biological Complexity and Integrative Pluralism*, 2003, pp. 115 ff. for critical discussion of this view.

so under certain circumstances). Expressed in this way, scientific knowledge may appear to be generally valid in the first, very extensive sense. Most scientists would, however, agree that it is only generally valid in the second, more constrained sense. Its given domain is the situation in which the knowledge was acquired. To what extent it is valid in other situations too (i.e. to what extent other situations are sufficiently similar to establish the existence of relations between entities of the same kinds there) is a separate question which must be answered in relation to that particular situation. In a legal context, this is a legal question which should be settled according to legal standards of proof.[280] The present discussion will therefore focus on relations that occur in situations in which the scientific information is acquired.[281] This will allow us to discuss the legally important question to what extent the existence of other, legally relevant relations can be established by means of these scientifically known relations and legal standards of proof.

Finally, it can be observed that legal relations will typically differ from scientifically known relations between particulars in a natural context, too. Although the relations in this case are of the same kind according to my categorization, they will hold between different particulars and in different contexts. Thus here, too, the relations that the legal questions introduce will be relations *other* than those that are scientifically known.

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[280] See the discussion about the epistemological differences between law and science and the priority of legal standards of proof in a legal context in Section 1.2.1.

[281] Scientific establishment of these relations requires inductive reasoning too. (See Sections 1.1 and 1.2.1). There is hence no sharp boundary between these relations and relations to which this knowledge subsequently is generalized or extrapolated. This, however, should not be a problem in the present investigation, where the conception of such a boundary merely serves to enable a comprehensive assessment of the possibility of establishing legally relevant relations through the application of scientific information and legal standards of proof (see Sections 1.2.3 and 4.4.4).

5.3.3 Similarity and Empirical Correlation

If legal questions seek relations other than those that appear in science, the question arises how, and under what conditions, scientifically known relations provide information about, and support, the existence of the former. This question will be discussed at length in the next chapter. However, two features that are relevant to such "inter-relational" inference should be mentioned at this stage. One of these is the *similarity* of the different relations; the other is what I call the *empirical correlation* between a relation in a group and relations among the group's members. Discussions of these and related features can be found in much of the literature that deals with the possibility of drawing conclusions about particular cases from general knowledge in legal and non-legal contexts.[282] The short discussion in this monograph will not examine every aspect of such inference. However, the reflections set out in this and the next chapter will highlight some important obstacles to the establishment of legally relevant relations by applying scientific knowledge.

How much support a scientifically known causal relation provides for the existence of a legally relevant relation depends, *inter alia*, on how similar the two relations are thought to be. In order to provide *any* such support, the scientifically known relation must first of all be similar to the legally relevant relation in respect of the cause and effect. Accordingly, the legal cause and effect must instantiate entities that are either of the same kind as those in the scientifically

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[282] See, for example, the notions of *scope* and *strength* in Mitchell, *Biological Complexity and Integrative Pluralism*, 2003, pp. 125 ff.). See also Parascandola's discussion of the difficulties involved in the notion of personal causation in "What is Wrong with the Probability of Causation?", 1998, pp. 35 ff., and, more generally, discussions of the so called reference class problem in, for example, Colyvan and Regan, "Legal Decisions and the Reference Class Problem", 2007, Hempel, "Aspects of Scientific Explanation", 1965, pp. 376 ff. and Von Mises, *Probability, Statistics and Truth*, 1981 (1957), p. 11. Similarity is also an important element in analogical reasoning about legal matters: see, for example, Reidhav, *Reasoning by Analogy*, 2007.

known relation or believed to be relevantly similar to the latter. For example, scientific information about the increased risk for lung cancer after exposure to substance *x* will typically provide some support for the existence of a legally relevant relation between a particular case of *x* exposure and a particular onset of lung cancer. Such information might also provide some support for the existence of a legally relevant relation between *x* and similar effects, such as other forms of cancer that are believed to have an aetiology like that of lung cancer. It will not, however, provide support for the existence of a relation between *x* exposure and, say, acidification.

As said above, the existence of a relation between particulars will typically depend on the absence and presence of a large number of conditions. In addition to the cause and effect, the legal and scientific relations may also be more or less similar with respect to these other contributing or counteracting conditions. Similarity with respect to these other conditions is also of importance for the support that a scientifically known relation can be taken to provide for the existence of a legally relevant relation. Let us assume, for example, that *x* exposure is known to increase the risk of lung cancer in 60 year-old men. To begin with, it is important to determine whether the conditions in the legally relevant situation are of the same kind as those in which the scientifically known relation holds. Some legal questions may indeed ask about the relation between exposure to *x* and lung cancer in a 60 year-old man. Others may focus on the relation between *x* exposure and lung cancer in a 60 year-old woman or a 30 year-old man. The support that the scientifically known relation can be taken to provide for the existence of a legally relevant relation will depend on whether these differences are believed to be causally relevant.

Furthermore, we have seen that scientific strategies have been devised to render information about the contribution of many conditions irrelevant to the discovery of causal relations. Even when causal relations between particulars in a natural context are scientifically known, this knowledge will only take a relatively small

number of conditions into account. Scientific knowledge of causation is thus normally not very detailed with respect to interacting causal conditions.[283] In a legally relevant situation, many conditions may therefore obtain whose causal relevance has not been taken into account by science and the scientifically known relation. These conditions too can be relevant to the support that the scientifically known relation provides for the existence of a legally relevant relation. For example, a 60 year-old man who has been exposed to *x* and subsequently developed lung cancer may be known to have spent several years cooking food in a badly ventilated kitchen in Taiwan, to have climbed Mount Everest twice, and to have lived in a radon house in which he had a vegetable-heavy diet. Some such factors may be known or believed to be associated with lung cancer even if details about their interaction with *x* exposure are largely unknown.[284] Hence, they may be relevant to whether a legally relevant relation between the exposure and lung cancer holds in this particular case, and to the support that the scientifically known relation provides for its existence.[285]

The situation is similar with respect to scientifically known relations between particulars. For example, assume that it is scientifically known that the introduction of a particular foreign species has led to ecological disturbance in a particular environment. The support this knowledge provides for the existence of a relation between the introduction of the same species and ecological disturbance in *another* environment depends on the particular genetic traits of the introduced animals (or plants), and on the ways

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[283] See Section 4.4.2.

[284] See, for example, Ko et al. "Risk Factors for Primary Lung Cancer Among Non-smoking Women in Taiwan", 1997, pp. 24 ff.

[285] The relevance of such factors will in part depend on whether the question is retrospective or prospective as well as on whether the NESS test or the but-for test is assumed. See Chapter 6.

in which the second environment is known to differ from the first with respect to relevant resources and limitations.[286]

Let us now turn to the second feature of relevance to inter-relational inference, namely the empirical correlation between a scientifically known relation in a group and relations among the group's members. As discussed in Chapter 4, a particular cause will rarely give rise to a particular effect in every member of a group that has been exposed to it. Let us, as an example, assume that 4% of those who have been exposed to *x* have been found to develop lung cancer, as compared with 2% of those who have not been exposed. This finding suggests that lung cancer is twice as common among those who have been exposed to *x*. The empirical correlation between this relation between *x* exposure and lung cancer at group level and the relations in the group's individual members will vary, depending on the sub-groups to which the members can be referred. Thus, in the sub-group whose members have been exposed to *x*, the empirical correlation can be expected to be at least 2%.[287] This figure refers to the difference between the incidence (or "risk") of lung cancer in the group whose members have been exposed to *x* as compared to the incidence of lung cancer in the group of non-exposed members. This is often conceived of as the incidence that is *attributable* to the exposure and hence referred to as "attributable risk".[288] The empirical correlation is considerably higher with respect to the sub-group whose members have been exposed to *x and* developed lung cancer. In this group, the empirical correlation between the scientifically known relation between *x* exposure and

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[286] See, for example, Wonham, "Species Invasion", 2005, p. 314. An additional difficulty is that many of the conditions in the situations from, and to, which the scientific knowledge is extrapolated will be unknown; see, for example, Gelpe and Tarlock, "The Uses of Scientific Information in Environmental Decision-Making", 1974, pp. 396 ff.

[287] See Section 6.7.2 for a discussion of this figure's relativity to how we understand the causal relation.

[288] See, for example, Fletcher and Fletcher, *Clinical Epidemiology*, 2005, pp. 85 f.

lung cancer, on the one hand, and relations in particular individuals, on the other, can be expected to be at least 50%. (The other 50% of the members of this group could have been expected to develop lung cancer also in the absence of *x* exposure.) [289] This latter empirical correlation is often referred to in terms of "relative risk".[290] The support that the scientifically known relation provides for the existence of a legally relevant relation increases with the empirical correlation between the scientifically known relation in a group and the members of the sub-group to which the legally relevant situation can be referred. This support is thus stronger for a group whose members have been exposed to *x and* developed lung cancer than it is for a group whose members have been exposed to *x* but where it is also unknown whether they have developed lung cancer or will eventually do so.

It should be observed that often not one, but a number of scientifically known relations are relevant inasmuch as they support or contradict the existence of a legally relevant relation. In the example above, about the introduction of a species to a new environment, general information about conditions that are relevant to species invasion would thus normally be relevant too.[291] Sometimes, complex models can be used, for example, to make computerized predictions. Just as inadequate similarity or a weak empirical correlation (as we shall see) can constitute obstacles to the establishment of legally relevant relations by applying relatively simple scientific information, they can hinder, also, the establishment

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[289] Again, the adequate figure here depends on how we understand the causal relation.

[290] See, for example, Fletcher and Fletcher, *Clinical Epidemiology*, 2005, p. 86. In this example, where lung cancer is twice as common among those who have been exposed to *x*, the relative risk, of lung cancer associated with *x* exposure is 2.

[291] Wonham, "Species Invasion", 2005, pp. 306 ff.

of legally relevant relations through the application of more complex combinations of such information. [292]

5.4 Conclusions

In Chapter 2, I said that because the considerations that underlie law and science differ, legal and scientific categorizations of the world can be expected to differ too. In Chapter 3, this expectation was incorporated in a hypothesis, *H1*, which claimed that *the entities that the two legal questions are about differ from scientifically known entities*. In the present chapter, we have seen how, more precisely, the entities that the two legal questions are about differ from entities that are scientifically known. The discussion has shown that the legal categorizations that demarcate these entities differ from scientific categorizations with respect to both the kinds and the individuals that they recognize. In particular, we have seen that legally relevant causes and effects will contain scientific entities as *parts*, but that these parts will not normally exhaust the causal capacity of the legal entities. The causal relations that the legal questions bring into view, on the other hand, can often be referred to another kind, and they are generally relations *other* than those that are scientifically known. *H1* has hence now been confirmed.

Chapter 3 also stated another hypothesis, *H2*, which claimed that *these differences will systematically hamper efforts to establish the relations sought when questions of the two sorts are raised*. In the next chapter, this hypothesis will be tested in the course of a discussion of obstacles to the establishment of these legally relevant relations by applying scientific information. On the basis of the conclusions reached in the present chapter, a question of importance to this discussion can now be put as follows: What obstacles hinder the

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[292] In addition, the combination of different pieces of scientific knowledge in such models is in itself a source of uncertainty; see Morgan and Henrion, *Uncertainty*, 1992, pp. 67 ff.

establishment of legally relevant relations between legally relevant entities through the application of information relating to *other* relations between *parts* of these entities?

6 Epistemic gaps

6.1 Introduction

This chapter discusses some obstacles to the establishment of legally relevant causal relations through the application of scientific information. Section 6.2 presents reasons to assume, *prima facie*, that such obstacles exist. Section 6.3 contains a brief discussion of the relevance of legal standards of proof, and of epistemological differences between law and science in this respect. Section 6.4 lists four differences between legal questions which, equally, are potentially relevant. Section 6.5 distinguishes two inferential steps in the establishment of legally relevant relations through the application of scientific information. In Section 6.6 some obstacles involved in the first of these steps are examined. Section 6.7 discusses obstacles involved in the second step. A short summary of the chapter's most important conclusions is given in Section 6.8.

6.2 Prima Facie Obstacles

It is obvious that some legally relevant relations *can* be established through the application of scientific information. However, we have seen above that the causes, effects and causal relations that the two legal questions seek generally differ from causes, effects and causal relations that are scientifically known. More precisely, we have seen that legally relevant causes and effects often include a number of scientifically known entities as their parts. We have also seen that the

law targets relations of a kind quite unlike many of the scientifically known relations. Because the boundaries of the legally relevant entities are relative to legal considerations, they cannot be identified with their scientifically known components or counterparts. Furthermore, we have seen that the scientific knowledge is fragmentary with respect to the causal structure of the world that it aims to account for.

This raises the question to what extent legally relevant relations between legally relevant entities can be established on the basis of fragmentary knowledge relating to *other* relations between *parts* of these entities. In the rest of this chapter, some of the obstacles that are important in this respect and the epistemic gaps that they give rise to will be discussed in more detail. As we shall see, many of the relations that the two legal questions focus upon *cannot* be established by applying scientific information.

6.3 The Relevance of Epistemological Differences

The discussion in Chapters 2-5 concerned *ontological* differences between law and science. However, a discussion of the possibility of establishing legally relevant relations through the application of scientific information must also take the *epistemological* differences between law and science into account. As will be recalled from Chapter 1, epistemological differences are differences between the standards of proof that apply in legal and scientific contexts.[293] As explained at more length there, such differences arise because of the different purposes that inferences made by these standards serve in these contexts. Because the applicable standard of proof is relative to considerations of relevance in the context in which it applies, legal standards of proof should be given priority when the context is legal.

[293] See Section 1.2.1.

If a legal standard of proof is lower than a scientific standard, it may allow for inferences that the scientific standard does not permit. Recognition of the epistemological differences between law and science can, therefore, narrow the epistemic gaps that may otherwise arise when legal questions are answered on the basis of scientific knowledge.

It is a matter for discussion exactly what factors bear upon the legal standard (and burden) of proof and how. Some factors that are regularly mentioned as relevant in this respect are the disutility of incorrect verdicts, the possibility of providing evidence, the relative strengths of the parties, and the societal consequences of the standard of proof chosen.[294] As a result, the standard of proof required by the law varies between the legal contexts. For one thing, the standards of proof typically differ from one branch of the law to another – e.g. the standard of proof in a criminal case is typically higher than that in a tort case. Furthermore, the standards of proof required differ from issue to issue within the same case.

The burden of proof normally falls on the party claiming that a legally relevant causal relation exists.[295] Chap. 32 sec. 3 par. 3, Environmental Code, sets the standard of proof for the causal relation required for *tort liability* for much environmental damage to a preponderance of the evidence. The section confirms a general development in case law towards a relaxation of the standard of proof with respect to many causal relations, noting that such relations often are marked by evidential difficulties.[296] The precise

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[294] See, for example, Ekelöf, *Rättegång IV*, 2009, pp. 81 ff., pp. 94 ff., and pp. 151 ff., Heuman, *Bevisbörda och beviskrav i tvistemål*, 2005, Klami et al., *Law and Truth*, 2000, pp. 49 f. and 195 ff., Lindblom, *Miljöprocessen D II*, 2001, pp. 355 ff. and pp. 493 ff., and Lindell, *Civilprocessen*, 2003, pp. 505 ff.

[295] One possible rationale for this localization of the burden of proof is that it often is seen as impossible to prove the negative; see, for example, Lasagna and Schulman, "Bendectin and the Language of Causation", 1993, p. 109 and Hansson, "Can We Reverse the Burden of Proof?", 1997, p. 225.

[296] Govt. Bill 1997/98: 45, part 2, p. 341 and Govt Bill 1985/86: 83, p. 46.

meaning of this relaxation is a matter of debate and seems to differ across legal contexts, but typically this kind of relatively low standard does not imply a reversal of the *burden* of the proof, which remains with the party who claims the causal relation's existence.[297]

The Precautionary Principle is a well known principle which in many legal and political contexts is seen as a guide to *preventive* action under uncertainty. A general characteristic of the Precautionary Principle is that it allows for action in cases of uncertainty, but its precise meaning differs substantially between the contexts in which it is used.[298] The Precautionary Principle is found in chap. 2 sec. 3 par. 2, Environmental Code, which states that "precautions shall be taken as soon as there is cause to assume that an activity or measure may cause damage or detriment to human health or the environment". The phrase "cause to assume" is interpreted not as full scientific proof, but rather as a scientifically well-founded suspicion.[299] It is unclear exactly what this means

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[297] In Swedish case law, it is sometimes required that the causal relation must be "clearly more probable than any explanation provided by the other side and probable in its own right". (See, for example, NJA 1981, p. 622 and NJA 1982, p. 421. Cf. NJA 1992 p. 113, about insurance liability, where the Supreme Court distinguished the standard "clearly more probable than not" from the even lower standard "more probable than not". (See also discussion in, for example, Carlsson, *Arbetsskada*, 2008, pp. 446 ff. and Heuman, *Bevisbörda och beviskrav i tvistemål*, 2005, pp. 79 ff.)

[298] Sandin has distinguished four variables or "dimensions" (threat, uncertainty, action and command) in the different formulations of the Precautionary Principle. He argues that the principle's strength (stringency) depends on the precision and strength of these variables. (Sandin, "Dimensions of the Precautionary Principle", 1999, pp. 889 ff. and *The Precautionary Principle*, 2002, pp.10 f.).

[299] See, for example, Michanek, "Sweden", 2007, p. 122 and p. 127 and Nilsson, "Man skall vara försiktig", 2002, p. 417 on the interpretation in Sweden. See also de Sadeleer, "The Precautionary Principle in European Community Health and Environmental Law", 2007, p. 20 on European health and environmental law. Ignorance or a mere "hypothetical risk" does thus not constitute "cause to assume" according to the Precautionary Principle in Swedish law (cf. Sahlin and Persson,

when the principle applies to a scientific material, but the principle can reasonably be interpreted as involving at least some relaxation as compared to scientific standards of proof.

The Precautionary Principle is sometimes interpreted as implying a reversal of the traditional localization of the *burden* of proof.[300] In Swedish law, such an interpretation may seem to gain some support from the sometimes rather onerous burden of investigation which the Environmental Code places on the operator, as well as from the requirement that the operator must show that the obligations that arise out of the Code's second chapter are complied with.[301] However, to say that these requirements imply a reversal of the burden of proof with respect to the causal relation would be at least partly misleading.[302] The requirements in Chapter 2 will never involve more than what is scientifically possible. Existing scientific evidence must still provide some positive support for the existence of a causal relation in order to trigger the Precautionary Principle in chap. 2 sec. 3 par. 2, Environmental Code.

Legal standards of proof therefore typically require the relation to be supported by some positive scientific evidence.[303] Legal consequences that presuppose the existence of a causal relation will not ensue, then, unless this existence is somehow inferable from the scientific evidence. The possibility of establishing legally relevant causal relations using scientific evidence will thus determine the practical scope of rules that prescribe such consequences. It is therefore important to examine to what extent legally relevant relations can be established by scientific evidence. This is the

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"Epistemic Risk", 1994, pp. 37 ff., for a theoretical discussion of the possibility of regarding ignorance as a risk).

[300] See, for example, Earll, "Common Sense and the Precautionary Principle", 1992, pp. 182 ff. Cf. Hansson, "Can We Reverse the Burden of Proof?", 1997, pp. 223 ff.

[301] See chap. 2 secs. 1 and 2, and chap. 6, Environmental Code.

[302] See also Peel, The Precautionary Principle in Practice, 2005, pp. 154 f.

[303] Unless, that is, other (non-scientific) evidence suffices to establish the causal relation's existence (cf. Section 4.4.1 above and note 328 below).

purpose of the rest of this chapter. In such an enquiry, a rough understanding of the legal standard of proof will suffice. Here, this standard will be taken to be relatively low, but assumed to demand some support for the existence of a causal relation. The difficulties to be discussed are thus difficulties that arise *despite* the application of a low standard of proof to the scientific material. To the extent that a stricter standard of proof than the one assumed here applies in practice, establishment of legally relevant causal relations will typically be even more difficult.

In assuming a low standard of proof, the following discussion will show the limits of the recognition of the epistemological differences between law and science, and of giving priority to legal standards of proof as means to promote the establishment of legally relevant relations. It will also show the limits of a commonly used strategy to relax the legal standard of proof in this respect (insofar as this strategy does not amount to an actual reversal of the burden of proof). This strategy of relaxation may appear just and generous to plaintiffs when assessed on a case-by-case basis. However, as we shall see, the possibility of establishing legally relevant causal relations is *generally* highly restricted despite the implementation of such a low standard.[304] This means that other strategies are needed if the detrimental consequences of human behaviour are indeed to be counteracted.

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[304] It is often assumed that a low standard of proof, such as a preponderance of the evidence, promotes a maximization of the number of materially correct verdicts. (See, for example, the discussion in Heuman, *Bevisbörda och beviskrav i tvistemål*, 2005, pp. 45 ff.) It should, however, be noted that the application of the "preponderance of the evidence" standard does not guarantee a preponderance of materially correct verdicts. The possibility of proving the relevant *kind* of fact by a preponderance of the evidence is likewise relevant in this respect, and this possibility may very well be asymmetrical with respect to the fact and its negation.

6.4 The Relevance of Differences between the Legal Questions

As we have seen, the questions "Did this behaviour cause the damage?" and "What damage, if any, will this behaviour cause?" both seek to identify relations between particular human behaviour and particular damage. However, as the discussion in Chapter 3 has shown, there are differences both between these two kinds of question and between the entities to which they apply. Some of these differences may very well be relevant to the possibility of establishing legally relevant relations by applying scientific information. In this section, I will list four differences that are potentially relevant in this respect. The actual relevance of these differences to the possibility of establishing legally relevant relations via scientific information will be discussed in more detail in the following sections. The first two differences to be listed can, at least in theory, arise irrespective of whether the questions are of the retrospective or the prospective kind. The last two are differences between retrospective questions, as they arise in the application of the rules discussed here, on the one hand, and prospective questions, on the other.[305] Although all four differences relate to questions about relations between particular behaviour and particular damage, elements of the discussion apply, directly or analogously, to, for example, legal questions of a general nature, too.[306] Where appropriate, this will be noted in passing.

The **first** difference is between questions that point us towards relations between human behaviour and *intrinsic* damage and questions focusing on relations between human behaviour and what I have called *absolute instrumental* damage. In this terminology, intrinsic damage is damage of a kind that the law ultimately aims to counteract. Absolute instrumental damage falls short of intrinsic

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[305] Another kind of retrospective question will be discussed in Section 7.4.4 below.

[306] See Section 3.2.2.

damage, but it is nevertheless regarded as legally relevant because it has the general capacity to cause such damage.[307] The application of chap. 2 sec. 3, Environmental Code, often implies a responsibility to take action to prevent effects that are best explained as absolute instrumental damage. An example of such an effect is the discharge, or increased level in nature, of a substance that is generally known to be detrimental. If such a discharge or increase can be expected, preventive measures may be required irrespective of what intrinsic damage is expected to ensue.

The **second** difference to be examined is that between the *NESS test* and the *but-for test*. As discussed in Chapter 3, these have both been put forward as tests for the existence of a legally relevant causal relation. The but-for test requires that the effect would not have occurred in the absence of (but for) the potential cause. The NESS test, on the other hand, requires that the cause is a necessary part of a set which is sufficient, but need not be necessary, for the occurrence of the effect. Some reasons given for choosing the NESS test rather than the but-for test allude to claims about the nature of "true" causation.[308] However, if one of the tests is epistemically superior to the other, this should also be relevant to the choice between them.

The **third** difference to be discussed is the difference between the ways in which questions of the retrospective kind and those of the prospective kind *identify the effect*. Since retrospective questions take as their starting point particular damage that has already occurred, the damage in this question is ostensively identified. In the prospective question, by contrast, the damage – which has not yet occurred – needs only be identified as damage of a certain legally relevant kind.

The **fourth** difference is a difference with respect to the *point in time* at which the retrospective and prospective questions are raised. A retrospective question that asks for the same relation as a

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[307] See Section 3.3.2.

[308] See Section 3.3.3.1.

prospective question will differ from the latter by being put both at a later stage and after, instead of before, the occurrence of the effect.[309]

6.5 Two Inferential Steps

The establishment of a legally relevant relation between particular behaviour and damage through the application of scientific information can be divided into two inferential steps. The first of these consists in the establishment of an *association between scientific kinds* of entity that the particular behaviour and damage instantiate. (Obstacles to this first inferential step will likewise threaten the impact of rules which require the establishment of an association between kinds, but not between particulars.[310]) The second step consists in the establishment of a legally relevant *relation between instances* of these kinds. This second step is required because the retrospective and prospective questions ultimately seek to identify relations between particular behaviour and particular damage.

The following discussion aims to clarify why, where, and to what extent epistemic gaps arise in these two steps. Similar

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[309] As discussed in Chapter 3, a further difference is that a prospective question generally asks for a larger number of causal relations than a retrospective one does. Consequently, the prospective question should also be more difficult to answer. However, this apparent epistemic advantage of the retrospective question does not reflect the possibility of establishing legally relevant relations, but the possibility of answering a particular instance of questions of this kind. In order to establish all relations that a prospective question applies to, a corresponding retrospective question would have to be applied repeatedly, and if it were, its apparent epistemic advantages would vanish. The space for using a particular retrospective question to counteract damage is directly restricted by its limited scope. Therefore, this difference between the two questions will not be discussed here.

[310] See Section 3.2.2.

distinctions between two inferential steps are rather common in contexts where the establishment of legally relevant relations between particulars via scientific information is at issue.[311] It should, however, be observed that the difficulties to be discussed arise as a result of differences between the entities that legal questions and scientific information are about – not because the establishment of the legally relevant relation involves two inferential steps. (The *legally relevant relations* typically hold between instances (step 2) of *kinds that (possibly) are scientifically known to be associated* (step 1) *other than* those in which a relation is scientifically known to obtain.) What is said below is therefore also relevant in contexts where a two-step procedure is not explicitly adopted.

The first step, involving the establishment of associations between kinds, will be discussed in Section 6.6 below. The second,

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[311] Variants of these two steps (sometimes referred to in terms of "general causation" and "personal causation") can be found in many discussions of the inference of legally relevant causal relations by applying scientific evidence. See, for example, Geistfeld, "Scientific Uncertainty and Causation in Tort Law", 2001, p. 1022, Goldberg, *Causation and Risk in the Law of Torts*, 1999, p. 144, Hutchinson and Hodgson, "Who's Zoomin' Who?", 1991, p. 101 and Khoury, *Uncertain Causation in Medical Liability*, 2006, p. 49. The Swedish requirement that the causal relation must be clearly more probable than any explanation provided by the other side, and also probable in its own right, does not – because of the reference to the circumstances in the case (see, for example, NJA 1981 p. 622, at 632 and NJA 1982 p. 421, at 482 f. and note 319 below) – seem to be based on these two steps. However, the courts' reasoning in Swedish case law suggests that an established association between kinds is regarded as relevant (see, for example, NJA 1981 p. 421, at 479 and note 322 below). In Govt. Bill 2001/02: 81 pp. 40 ff. (on some issues pertaining to industrial injuries), an earlier regulation which explicitly prescribed the application of a strict standard of proof to the first step and a more relaxed standard to the second was abandoned in favour of a more holistic assessment on the basis of a preponderance of the evidence. As the discussion in the Bill and in Sections 6.6.1 and 6.6.7 below suggests, such a holistic assessment makes neither of these two steps irrelevant; it means that the degree of certainty required for one of the steps is relative to the degree of certainty that has been provided for the other.

involving the establishment of legally relevant relations between particulars, will be discussed in Section 6.7. As was mentioned in Section 6.3, epistemological differences between law and science should be taken into account in a discussion of the possibility of establishing legally relevant relations by applying scientific information. Sections 6.6.1 and 6.7.1 therefore contain general discussions of the possibility of taking each of the inferential steps given that legal – not scientific – standards of proof are applied. As was said in Section 6.4, differences between the legal questions may also be relevant in this respect. The relevance of these differences is discussed at greater length in Sections 6.6.2 and 6.7.2.

Let us now assume that a relation between particulars such that sought by the retrospective and prospective questions indeed exists. Depending on how we understand the legal requirement of causation this may, for example, imply that some particular damage would not have occurred but for a particular behaviour (the but-for test) or that the behaviour was a necessary element of a set which was sufficient for the occurrence of the damage (the NESS test).[312] As we shall see in the following sections, there is a significant risk that this relation cannot be established on the basis of scientific information owing to failures to conduct the first and/or the second inferential step.

[312] See Section 3.3.3.

6.6 The Establishment of Associations between Kinds

6.6.1 General Limits to the Establishment of Associations between Kinds

As the discussion in Chapters 3-5 has shown, legally relevant behaviour and damage instantiate a very large number of distinct scientific kinds of entity. This is often the case already as regards the particular behaviour and damage for which a person in an actual case can be held responsible. It is even more obvious with respect to all behaviour and damage that is of relevance to a particular rule, or to the more general legal aim to counteract detrimental consequences of human behaviour.

Many scientifically relevant kinds of entity are known to be causally related in a number of different ways. To mention just a few examples: aluminium is known to kill fish directly by preventing their gills from absorbing oxygen from water, but it may also kill fish via the acidification that it is also known to give rise to.[313] Aluminium is also potentially toxic to human beings, with suspected links with Alzheimer's disease.[314] Nitrogen is a well known cause of eutrophication, and thereby causally associated with, for example, anoxia, fish death and other known consequences of eutrophication. It is also known to, for example, be implicated in acid rain and to affect the ozone layer and the human respiratory system.[315] Phosphate is another important cause of eutrophication, and CFCs are another well known cause of holes in the ozone layer.[316] The various ways in which different kinds of entity are known to be

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[313] Baird and Cann, *Environmental Chemistry*, 2008, pp. 153 f. and p. 597.
[314] Baird and Cann, *Environmental Chemistry*, 2008, p. 597.
[315] Baird and Cann, *Environmental Chemistry*, 2008, pp. 75 f., pp. 147 ff. and p. 167.
[316] Baird and Cann, *Environmental Chemistry*, 2008, pp. 640 ff. and pp. 77 ff.

associated indicate that we live in a world with a highly complex causal structure.[317] It should, then, be obvious that the scientific kinds that are instantiated by legally relevant behaviour and damage can be related in numerous ways.

Some legally relevant relations will certainly instantiate scientific kinds that are known to be associated. However, there is reason to assume that many legally relevant relations exist without instantiating such kinds. To begin with, many scientific kinds are presumably associated without being known to be so. As was discussed at length in Chapter 4, our scientific understanding of the world is fragmentary. What kinds are known to be causally related depends not only on what the world is like but also on what studies have been conducted. What studies have been conducted depends on scientific and societal interests, the availability of time, of researchers, and money. In addition to the constraints implied by limited resources, some studies may not be morally or practically feasible – e.g. because they require human beings to be put at deliberate risk or involve long-term effects. As also seen in Chapter 4, some important and frequently adopted scientific techniques will generally fail to detect certain kinds of effects. Because of systematic constraints like these, many detrimental effects of DDT, PCB and thalidomide (to name just three examples) of which we are now aware were until recently scientifically unknown, and many other effects of these and other entities undoubtedly still are. Presumably,

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[317] The metaphysical belief in a complex and diverse world is a central element in many contemporary philosophers' approach to science and scientific method. (See, for example, Cartwright, *How the Laws of Physics Lie*, 1983, p. 19, Dupré, *The Disorder of Things*, 1993, p. 1 and Mitchell, *Biological Complexity and Integrative Pluralism*, 2003, p. 115.) Cf. the NESS test which, as discussed in Section 3.3.3.1, requires that a cause is a necessary condition of a set which is sufficient for the effect to occur. According to this conception of causation, the same kind of entity may form part of a number of different sets, all of which are sufficient for different kinds of effects. Correspondingly, the same kind of effect may follow from a number of distinct, sufficient sets, some of which may include entities of the same kind.

a nearly endless list of presently unknown associations could be made some 50 years from now, and a further one 50 years later still. Furthermore, we saw in Chapters 2 and 5 that the legally relevant causes and effects are relative to legally relevant considerations and cannot be identified with their scientifically known components. The constant discovery of new causally relevant elements of the world suggests a considerable scientific ignorance with respect not only to the associations between known kinds but to explanatorily fruitful kinds as such.

For these reasons many legally relevant relations will presumably not instantiate kinds that are scientifically known to be associated. An important question is therefore to what extent the application of standards of proof which are lower than scientific standards can make the legal establishment of scientifically unestablished associations possible. *Prima facie*, the application of lower standards seems to allow for extrapolations from associations that are scientifically known to associations for which the evidence does not meet scientific standards. As discussed in Chapter 4, extrapolation is a recognized scientific strategy of extending scientific knowledge too. Thus, knowledge of the effects of a particular chemical substance on humans can sometimes be extrapolated from knowledge of its effects on some rodent, or from knowledge of the effects of some other, similar substance. If legal standards of proof, such as the Precautionary Principle, are indeed less demanding than scientific standards, the application of the former might allow for extrapolations that do not pass the latter. The application of lower, legal standards of proof to particular studies also seems to allow for the detection of associations which would not be detected against a stricter standard.

Even so, the possibility of establishing associations that do not meet scientific standards of proof through the application of a lower, legal standard of proof is presumably highly limited in practice. As discussed above, legal standards of proof typically require some positive support for the existence of a legally relevant relation in order to allow for its establishment. This requirement constitutes a major constraint on the associations that can be established by applying such standards. For example, extrapolation from known to

unknown associations requires some reason to assume that the kinds to which the extrapolation is made are relevantly similar to the kinds that are known to be associated. This excludes extrapolation to associations beyond already known kinds and generally seems to presuppose knowledge (or the suspicion) of some *other*, underlying, causally relevant element which the different kinds of cause and effect have in common.[318] Furthermore, the possibility of establishing associations by applying lower standards of proof is constrained by the studies that have actually been conducted. The detection of long-term effects, rare effects and synergetic effects will require studies with a particular design or approach (long-term studies, comprehensive studies, complex studies, and so forth) also if low standards of proof are being applied. More generally, the establishment of an association by applying lower standards of proof is restricted by the same kinds of problem that beset similar attempts to establish associations by applying stricter standards. The application of lower standards of proof can reduce the quantity of the epistemic gaps somewhat, but it does not permit the avoidance of systematic constraints. It is therefore reasonable to conclude that many existing legally relevant relations will not instantiate associations that can be established by applying lower standards of proof either. Already the first inferential step in the establishment of a legally relevant relation will therefore often be impossible, even if such a relation indeed exists.

Furthermore, the application of a relatively low legal standard of proof to the legally relevant relation does not imply that weak evidence suffices to show that two kinds of entity are associated. This is illustrated by the Swedish case NJA 1982, p. 421, in which the Supreme Court was asked to decide on the existence of a causal

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[318] For example, knowledge of the physico-chemical properties of new and untested chemicals can be used to predict their toxicity and bioaccumulatibility. (See Gray, "Integrating Precautionary Scientific Methods into Decision-Making", 1996, p. 137.) Information about the causal relevance of the underlying physico-chemical structure is of obvious relevance in this respect.

relation between the contrast medium Kontrast U and cauda equine syndrome. In this case, the Court applied a standard of proof which roughly required a preponderance of evidence in support of the legally relevant relation.[319] Animal studies indicated that Kontrast U was causally associated with cauda equine syndrome, and most experts in the relevant area believed in the existence of such an association.[320] In addition, material provided by one of the experts in this particular case suggested that Kontrast U significantly increased the risk for this kind of damage.[321] The Supreme Court, however, pointed out that the available statistical material was poor, that no biological mechanism between Kontrast U and cauda equine syndrome was known, and that the scientific evidence did not suffice to establish that Kontrast U causes cauda equine syndrome.[322] The application of a relaxed legal standard of proof to the legally relevant relation does not seem to have implied a significant relaxation as compared with the scientific standards involved in the first inferential step. Irrespective of the criticism that can be, and has

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[319] More precisely, the Court required that the legally relevant causal relation was clearly more probable than any explanation provided by the other side and also probable in its own right with respect to the circumstances in the case. NJA 1982, p. 421, at 482 f. (See note 297 and Section 6.3 above.)

[320] NJA 1982, p. 421, at 479.

[321] NJA 1982, p. 421, at 473 ff.

[322] NJA 1982, p. 421, at 479 ff. Nevertheless, the Court concluded that the legally relevant relation was probable in its own right despite the declared failure of the scientific evidence to show this (NJA 1982, p. 421, at 483). The ground for this conclusion was said to be the fact that usage of Kontrast U was the only factor that the plaintiffs' scenarios in this case had in common (!). This apparently relative disbelief in the scientific evidence indicates that the requirement that the relation must be "probable in its own right" does not apply to the existence of an association between the kind Kontrast U and the kind Cauda equine syndrome, but rather applies to the legally relevant relation (see note 311 above). However, the Court's reasoning about whether Kontrast U *could* cause such damage (*ibid* at 479 ff.) suggests that the establishment of an association between kinds was regarded as a factor of importance.

been, levelled at the Supreme Court's reasoning in this case,[323] application of a relatively low standard of proof to the *legally relevant relation* is, in fact, often compatible with higher demands on evidence supporting an *association between kinds* (a point to which I shall return in Section 6.7.1 below).

6.6.2 The Relevance of Differences between the Questions

We have now seen that the first inferential step in the establishment of a legally relevant relation risks failure even if such a relation indeed exists and a relatively low standard of proof is applied. In this section, I will discuss some ways in which differences between the legal questions drawing attention to these relations are relevant in this respect. Among the four differences distinguished in Section 6.4, two are particularly relevant to this first step. These are the difference between intrinsic and absolute instrumental damage, and the difference in the timing of the questions.

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[323] It has been complained that the Court's reasoning in this case is very hard on the plaintiff (see, for example, Hellner and Radetzki, *Skadeståndsrätt*, 2010, pp. 201 f.) and that the appropriate standard should have been "more probable than not" instead of "clearly more probable than not" (Heuman, *Beviskrav och bevisbörda i tvistemål*, 2005, p. 82). See also Björk, *Högsta Domstolen argumenterar*, 1988, for comprehensive criticism of the Supreme Court's reasoning in this case. Björk points out, among many other things, that the Supreme Court here seems to have applied a stricter standard of proof than the scientific standard. (*ibid* pp. 99 f.). Note, however, that the fact that the predominant view among physicians was that an association between Kontrast U and Cauda equine syndrome existed does not necessarily imply that such an association had also met rigorous scientific standards of proof.

6.6.2.1 Absolute Instrumental Damage and Intrinsic Damage

It is normally easier to establish an association between a kind that is instantiated by a particular behaviour and a kind of absolute instrumental damage than it is to establish an association between a kind instantiated by the same behaviour and a kind of intrinsic damage. In order for a kind of effect to qualify as absolute instrumental damage, it must be known to be associated with some kind of intrinsic damage. However, it is not necessary for every kind of intrinsic damage that this kind of effect is associated with to be known in order for it to qualify as absolute instrumental damage. In order to establish an association between a kind which a particular behaviour instantiates and a kind of absolute instrumental damage which is instantiated by its effects, we therefore need only to establish an association between the first kind and *some* kind of intrinsic damage. In order to establish an association between a kind which a particular behaviour instantiates and a kind of intrinsic damage which is instantiated by its effects, an association between the first kind and *this special* kind of intrinsic damage must be established.

For example, in order to establish a relation between behaviour that involves the release of aluminium and the occurrence of Alzheimer's disease, an association between aluminium and Alzheimer's disease must normally be established. Whether aluminium and Alzheimer's disease are associated or not is a controversial matter.[324] However, because aluminium is known to have other detrimental effects, raised levels of aluminium in the environment can be regarded as absolute instrumental damage. In order for it to qualify as absolute instrumental damage, an association between it and *some* intrinsic damage, such as acidification or some of its toxic effects on humans, must have been established. However, no association between aluminium and just the kinds of intrinsic damage that will, or are likely to, ensue in the particular case needs to be established.

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[324] Baird and Cann, *Environmental Chemistry*, 2008, p. 597.

This does not imply that the establishment of an association between a kind instantiated by a particular behaviour and a kind of absolute instrumental damage is trivial. To begin with, it need not be known that a kind of behaviour is associated with a kind of effect that qualifies as absolute instrumental damage. For example, the discovery that the traditional way to synthesize the raw material used in the preparation of nylon results in the release of large amounts of nitrous oxide was not made until 1990.[325] Even if raised levels of nitrous oxide are known to have detrimental effects and qualify as absolute instrumental damage, this is of little help unless we also know that a certain kind of behaviour is associated with its release. Furthermore, as mentioned above, in order to qualify as absolute instrumental damage, the intermediary effect must have been found to be associated with *some* intrinsic damage. For example, an association between nitrous oxide and some kind of intrinsic damage, such as global warming and its consequences, must have been established in order for the increase to qualify as absolute instrumental damage to begin with.[326] For reasons given in Chapter 4, many causally relevant elements can be assumed to be detrimental without being known to be so – or, at least, without being known to be sufficiently detrimental to ensure that their release into the environment qualifies as absolute instrumental damage. Presumably, many known effects of human behaviour that at present do not qualify as damage would qualify as absolute instrumental damage if some of the intrinsic damage they are associated with were known.

6.6.2.2 The Timing of the Question

Another difference with a bearing on the possibility of establishing associations between kinds is the difference in the times at which the

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[325] Baird and Cann, *Environmental Chemistry*, 2008, p. 242.

[326] Per molecule, nitrous oxide, or "laughing gas", is a 300 times more effective greenhouse gas than carbon dioxide (Baird and Cann, *Environmental Chemistry*, 2008, p. 242).

retrospective and prospective questions are asked. A retrospective question which asks for a legally relevant relation will be asked at a later stage than a prospective question asking for the same relation. More and more associations between different kinds of entity become scientifically known with time, and the occurrence of the effect can itself be relevant to the state of scientific knowledge. Many associations, such as that between thalidomide and birth defects, were unknown to science until damage was seen to occur in a natural context.[327] The probability that one and the same relation instantiates kinds that are scientifically known to be associated will therefore increase with time and thus typically be higher when the retrospective question is being asked than it is when the prospective question is being asked.

Moreover, if the cause stands out as a salient causal candidate, a causal relation can sometimes be legally established rather straightforwardly and without scientific knowledge. In these cases, the inferential step discussed in this section becomes superfluous.[328] Often, however, the causes and effects will be insufficiently salient to allow the legally relevant relation to be established by applying legal standards of proof unless there is scientific information about an association between kinds that they instantiate.

It should finally be observed that both the prospective and the retrospective question, which arise in the *application* of a rule, are typically asked and answered at a later point in time than the causal assessment on which some legal rules are *based*.[329] Associations that were unknown when a given regulation came into force may have become known by the time the retrospective and prospective questions are asked. By comparison with the causal assessments on which some rules are based, and which likewise involve the

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[327] Hennekens, *Epidemiology in Medicine*, 1987, p. 123.

[328] See the discussion in Section 4.4.1 of the possibility of perceiving singular causal relations directly. Some examples of such cases are discussed in, for example, Carlsson, *Arbetsskada*, 2008, p. 501 and Brooks et al., *Law and Ecology*, 2002, p. 218.

[329] See Section 3.2.2 above.

establishment of associations between kinds, both prospective and retrospective questions will therefore have the epistemic advantage of being put at a point in time at which the state of scientific knowledge is typically better.[330]

6.7 The Establishment of Legally Relevant Relations

6.7.1 General Limits to the Establishment of Legally Relevant Relations

In Section 6.6, we saw that the establishment of an association between kinds that a particular behaviour and damage instantiate will often fail even if a legally relevant relation indeed exists and a low standard of proof is being applied. Let us now assume, however, that the inferential step discussed in Section 6.6 *has* succeeded, and that an association between the instantiated kinds has been established. Let us also, as before, assume that a legally relevant relation between these instances exists. We can now, in this section, discuss some obstacles to the second inferential step – obstacles that may, at this later stage, impede establishment of the legally relevant relation through the application of scientific information.

The fact that two kinds are causally associated implies that *some* of their instances are causally related. It does not, however, imply that *all* of their instances are causally related. Above we have seen that whereas the two legal questions ask for relations between particulars in a natural context, many scientifically known relations are relations that occur in isolation or as distributions in groups. Some scientifically known relations are relations between particulars

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[330] On the other hand, and as indicated in Section 6.5, rules based on establishment of associations between kinds, avoid the epistemic difficulties involved in the establishment of legally relevant relations between particulars, examined in Section 6.7.

in a natural context too but when this is the case, the particular instances and the context in which they occur will normally differ from those of legal interest. Hence the relations that are scientifically known to hold between two kinds of entity are typically *relations other than* those examined in the legal questions. Of relevance to the possibility of establishing a relation between legally relevant instances is not only *that* these legal instances are of kinds that are known to be associated, but also under *what particular circumstances* any instances of these kinds are known to be related.

In Chapter 5, I mentioned two features of relevance to the support that a scientifically known relation provides for the existence of a legally relevant relation. The first was the *similarity* between the conditions under which the scientific relation is known to hold and the conditions known to obtain in the situation in which the legal relation might hold. The second feature was the *empirical correlation* between a scientifically known relation in a *group* and relations that hold among the group's particular members. Thus, as illustrated in Chapters 4 and 5, the fact that a relation between two factors (e.g. exposure to substance x and lung cancer) is known to hold in a group does not imply that these factors also are related in each of the group's members.[331]

Dissimilarity – or, perhaps better, insufficient similarity – sometimes seems to make knowledge of relations between instances of two kinds practically irrelevant to the establishment of a relation between other instances of the same kinds. This may be the case when the circumstances under which some such instances are known to be related are recognized as essential to trigger the kind of mechanism that is seen as responsible for the observed relation. Knowledge that a relation exists under these circumstances does not seem to provide much, or even any, support for the existence of a relation between instances of the same two kinds in a case where the essential conditions are known to be missing. This does not mean that no relation between the instances in this latter case exists; other

[331] Sections 4.4.2 and 5.3.3.

and unknown mechanisms between these kinds of entity may very well be triggered by other circumstances that are present in this particular case.

Typically, however, a known association will provide *some* support for the existence of a legally relevant relation between instances of the same kinds. Nevertheless, the support provided need not suffice to meet the applicable legal standards of proof; it need not enable a legally relevant relation to be established. Both insufficient similarity and/or empirical correlation can constrain the support that scientifically known relations provide in this respect.

To begin with, weak empirical correlation will often make it difficult to establish a relation between particulars. This is the case even when a relatively low standard of proof applies. Consider, for example, the possibility of establishing the relation that the retrospective question asks for by a preponderance of the evidence.[332] This kind of standard can be interpreted as implying that the legal relation must be at least more probable than not. In order to provide sufficient support for the existence of such a legal relation, a scientifically known relation with respect to a relevant group must reasonably be empirically correlated with relations among at least half of the group's members. When damage of the relevant kind is known to have occurred, it appears plausible to interpret this requirement as meaning that the cause must be known to at least double the risk of damage of the sort in question.[333]

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[332] See Section 6.3 above

[333] This interpretation was famously made by the Ninth Circuit Court of Appeals in *Daubert v Merell Dow Pharmaceuticals, Inc.* (1995), at 1320, according to which "[i]n terms of statistical proof [...] plaintiffs must establish not just that their mothers' ingestion of Bendectin increased somewhat the likelihood of birth defects, but that it more than doubled it – only then can it be said that Bendectin is more likely than not the source of their injury. Because the background rate of limb reduction defects is one per thousand births, plaintiffs must show that among children of mothers who took Bendectin the incidence of such defects was more than two per thousand." Although the interpretation of "preponderance of the evidence" to imply that the risk is more than doubled may appear

Knowledge of relations with weak empirical correlations (a characteristic of many of the detrimental consequences of human behaviour that affect us via the environment and are marked by a complex aetiology) will not suffice to establish the existence of legally relevant relations according to this standard and interpretation. This is so despite the fact that a scientifically known relation – even if it is weak – actually indicates that a number of legally relevant relations exist too. (Application of an even lower standard of proof will typically make the establishment of legally relevant relations easier in these situations.[334])

Even if the empirical correlation of a known relation is strong, the establishment of a legally relevant relation can be impeded by inadequate similarity between this and the scientifically known relation. Let us assume, as before, that exposure to substance *x* is known to double the risk of lung cancer in the population in general.[335] Another well known cause of lung cancer is smoking, which often gives rise to the disease in the absence of *x* exposure. Assume now that a retrospective question focuses upon the relation between an individual *smoker's* exposure to *x* and later development of lung cancer, and that this relation actually exists but needs to be established by a preponderance of the evidence. The person involved in this hypothetical case is thus known to have been exposed to another, generally very powerful cause of lung cancer in addition to *x*. The fact, assumed here, that exposure to *x* doubles the risk of lung cancer in the population in general does not imply that it also does so in the group of smokers, who run a higher risk than the average of developing lung cancer without such exposure. Knowledge of the doubled risk in the population in general will therefore hardly

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plausible (see, for example, Goldberg, *Causation and Risk in the Law of Torts*, 1999 p. 105, note 22), it is not uncontroversial. (See, for example, Parascandola, "What is Wrong with the Probability of Causation?", 1998, pp. 32 ff. and Section 6.7.2 below for a discussion.)

[334] Cf. the discussion in Section 6.7.2 of the relevance of the differences between retrospective and prospective questions in this respect.

[335] See Section 5.3.3.

suffice to establish a relation between the exposure and the lung cancer via a preponderance of the evidence in this case.[336]

Thus, even if the Supreme Court in NJA 1982 p. 421 (discussed in Section 6.6.1) would have accepted, for example, the animal studies as proof of an association between Kontrast U and cauda equine syndrome, this would not had guaranteed the plaintiffs' success in this case. The dissimilarity of animals and humans, and weak empirical correlations, could still have impeded the establishment of legally relevant relations. The same is true of the "statistical" material according to which Kontrast U introduced a six-fold increase in the risk of cauda equine syndrome. Despite this strong empirical correlation, differences between the plaintiffs and the average members of the studied population could nevertheless have impeded the establishment of a legally relevant relation.[337]

Insufficient similarity can impede the establishment of the relations sought in prospective questions too. For example, even if a certain kind of activity is known to be associated with decreases in the ground water level, this knowledge does not necessarily permit us to infer that such effects will follow in a particular situation: it will, for example, normally not do so in a situation in which the geological conditions are believed to be relevantly different from those under which such decreases are known to occur. A legally

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[336] Together with additional information about, for example, the synergetic effects of smoking and *x*, the genetic constitution of the smoking individual and/or the dose and length of the smoking and *x* exposure in the particular case, it may still be possible to establish such a relation. However, sufficiently detailed additional information of this kind is not generally available.

[337] The plaintiffs in the actual case all suffered from back disorders. In such a group, simultaneously used anaesthetics were believed to imply an increased risk of cauda equine syndrome. (See the reasoning by the Court of Appeal, NJA 1981, p. 421, at 467). Back disorders were likewise a possible confounder in the statistical material, where usage of anaesthetics and Kontrast U was compared with usage of anaesthetics only. (See the reasoning by the Court of Appeal, at 466 and by the Supreme Court, at 481).

relevant relation may certainly occur anyway, and involve conditions and interactions that have not been taken into account by the models used to make the predictions.[338]

It should finally be observed that the strength of the support for an association between *kinds* also affects the possibility of establishing the legally relevant relation between *particulars* in this second inferential step. In Section 6.6, I speculated that the application of a legal standard of proof that is lower than the scientific one could, perhaps, allow for the establishment of associations between kinds which cannot be established by scientific standards. As was also indicated there, this speculation now needs to be nuanced. If the support for an association between kinds is weak, the support that this association provides for the legally relevant relation – given the uncertainty necessarily involved in the second inferential step – is presumably even weaker. This shows that in order to make meaningful comparisons between legal and scientific standards of proof, we need to take into account to *what* these standards apply.[339] If legal standards of proof apply to relations other than the scientific standards, the establishment of the former by relatively low standards of proof may nevertheless require that

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[338] An illustration of the possible conflict between general abstract models and local particularistic knowledge is provided by Boholm, "Riskbedömningars ontologi och epistemologi, Hallandsåsen och dess vatten", 2005. See also O'Neill, *Ecology, Policy and Politics*, 1993, pp. 139 f. and Wahlberg and Persson, "Nya perspektiv på robusthet", 2005, pp. 225 ff. Factors of relevance in the particular case and knowledge of the general relevance of these factors can certainly also provide additional support *for* the existence of a causal relation. Thus, if it can be established that other possible causes are absent (in the retrospective question) or that the environment in a particular case is especially sensitive (in the prospective question), this information provides important additional support for the existence of a legally relevant relation. However, it is often hard to rule out alternative causes and detrimental effects can ensue in environments which are not known to be particularly sensitive too.

[339] The Framework of Epistemological and Ontological Differences, presented in Section 1.2 above, is therefore useful for discussions that focus on epistemological differences too.

other, scientifically relevant relations are established by higher standards.[340]

The discussion has shown that relatively low standards of proof can be difficult to meet. It is not only that many existing legally relevant relations presumably do not instantiate kinds that are known to be associated (as seen in Section 6.6); in addition, the empirical correlation of a scientifically known relation may be too weak to allow a legally relevant relation to be established. Furthermore, relevant differences between the actual situation and the known relation impose additional obstacles to the establishment of the legal relations. Thus, it is important to bear in mind that standards of proof that appear low and generous also expose those affected by the consequences of human behaviour to considerable risks.[341]

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[340] A prima facie too strict interpretation of the legal standards of proof as applied to the scientific evidence may thus be appropriate in the light of these ontological differences. (cf. the earlier prescribed application of distinct standards of proof to the two inferential steps in the establishment of relations pertaining to industrial injuries; see note 311 above.) It should be observed, however, that even if a weakly supported association does not by itself prove the existence of a legally relevant relation, it can nevertheless do so in combination with some other evidence and thereby provide relevant evidence.

[341] It would make a significant difference in this respect if the burden of proof – entirely or with respect to one of the inferential steps – were placed on the party who stands to benefit from a failure to establish a causal relation. (See discussions of the possibility of local partial or full reversals in, for example, Carlsson, *Arbetsskada*, 2008, 470 ff., Klami, *Law and Truth*, 2000, p. 265 and Khoury, *Uncertain Causation in Medical Liability*, 2006, pp. 77 ff.) As mentioned in note 295, a full reversal of the burden of proof is often seen as inappropriate because of the impossibility of proving the negative. However, the discussion in this chapter has illustrated that, also with a low standard of proof, it can be impossible to prove the positive.

6.7.2 The Relevance of Differences between the Questions

The possibility of establishing a legally relevant relation depends not only on the standard of proof, but also on the causal question. All four of the differences indicated in Section 6.4 are likely to be relevant in this respect.

6.7.2.1 Absolute Instrumental Damage and Intrinsic Damage

To begin with, it is typically easier to establish a relation between particular human behaviour and particular absolute instrumental damage than it is to establish a relation between particular behaviour and particular intrinsic damage. As was pointed out in Section 6.6.2, if something is to qualify as a kind of absolute instrumental damage, it must be known to be associated with some kind of intrinsic damage. However, to be legally relevant, a particular instance of absolute instrumental damage need not be related to any particular instance of intrinsic damage. Consequently, no relation between the particular behaviour and some ensuing particular intrinsic damage needs to be established here; it suffices to establish a relation between the particular behaviour and the particular absolute instrumental damage. The absolute instrumental damage as such is normally an intermediate effect which occurs at a point that is closer (in time and space) to the behaviour than the point at which intrinsic damage occurs. So when we compare absolute instrumental damage with damage of an intrinsic kind, we see that fewer conditions are likely to interfere with, and thereby threaten the establishment of a relation between the former and the particular behaviour.

6.7.2.2 The NESS Test and the But-for Test

Secondly, establishing a relation with the NESS test tends to be easier than establishing a relation with the but-for test. One reason for this is that the empirical correlation between a relation in a group and relations among its members can be expected to be stronger if the relation is understood in terms of the NESS test. As several writers

have already pointed out, scientifically established relations at group level will only reflect the frequency of effects which would not have occurred *but for* the cause.[342] This can, depending on our criteria for effect-identity, perhaps be seen as a reflection of the frequency of causal relations in terms of the but-for test among the group's individual members.[343] However, if the NESS test is assumed, the frequency in the group does not seem to reflect the number of causal relations among its individual members. According to the NESS test, the cause may very well have been a necessary element of a set which was sufficient for an effect that would have occurred also in the absence of the cause. Indeed, it has been pointed out that a cause may be a necessary part of an actual sufficient set of every effect which occurs in the test group (e.g. by accelerating every effect).[344] Yet, it is only reflected in the scientifically known relation to the extent that it gives rise to increased frequency of the effect in the particular study. If the NESS test is assumed, a possible way to compensate for this failure to reflect overdetermined effects is to assume a stronger empirical correlation than the scientifically known

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[342] Greenland and Robins, "Epidemiology, Justice and the Probability of Causation", 1999, p. 327. See also Geistfield, "Scientific Uncertainty and Causation in Tort Law", 2001, pp. 1032 ff. and Parascandola, "What is Wrong with the Probability of Causation?", 1998, pp. 37 ff.

[343] The criterion for effect-identity in a scientific study can be expected to differ from that applying in a legal context. If the effects are conceived of as more "fragile" in the latter, the frequency of legally relevant but-for-relations is presumably higher (cf. note 372 below and Lewis, "Causation as Influence", 2000, pp. 185 ff.). It can be observed that both Hart and Honoré and Wright are sceptical about the idea of solving causal issues by applying finer descriptions of the effect. (See Hart and Honoré, *Causation in the Law*, 2002 (1985), pp. xli ff. and Wright, "Causation in Tort Law", 1985 pp. 1778 ff. Cf. Adams, "The Flexibility of Description and NESS Causation", 2010)

[344] Greenland and Robins, "Epidemiology, Justice and the Probability of Causation", 1999, p. 325. Again, if temporal differences are regarded as relevant to effect-identity, the frequency fails to reflect all causal relations in terms of the but-for test too.

relation reflects.[345] If the empirical correlation can be assumed to be stronger when the causal relation is understood in terms of the NESS test, the possibility of establishing the legally relevant relation increases accordingly.

The choice between the NESS test and the but-for test is also relevant to the possibility of establishing a legally relevant relation through the application of information about the effects of large quantities of substances. To qualify as a cause against the but-for test, a particular individual emission of a certain substance must have made a difference with respect to the occurrence of the effect. This seems to imply that the quantity of the same kind of substance that comes from other sources must have been insufficient to produce the effect, although it sufficed to do so when added together with the particular emission. However, particular emissions of legally relevant (natural or juridical) persons are often small in comparison to the total quantities from other sources. If the total quantity suffices to produce the effect, the total quantity minus the quantity stemming from a particular emission will often do so, too. Because the effect presumably would have occurred without the particular emission, this emission does not qualify as a cause according to the but-for test. If the legally relevant relation is understood in accordance with the but-for test, it will therefore often be impossible to establish a relation between the behaviour and the effect. The NESS test, on the other hand, does not require that the effect would not have occurred but for the behaviour; it suffices, on this test, that the emission is part of an actual set which is sufficient for the occurrence of the effect. Thus, as discussed by Wright, a small emission may qualify as a cause according to this test even if it does not make a difference with respect to the effect.[346] If, however, the total quantity is significantly higher than that required, and if the emitted quantity is small in comparison, it may be difficult to prove, by a preponderance of the evidence, that the behaviour is part of an

[345] Cf. Parascandola, "What is Wrong with the Probability of Causation?", 1998, pp. 37 ff.
[346] Wright, "Causation in Tort Law", 1985, pp. 1791 ff.

actual sufficient set. A possible solution in these situations is, perhaps, to assume, as Wright does, that because substances generally mix, the particular emission, or a part of it, will generally constitute necessary elements of a set which is sufficient for the occurrence of the effect.[347]

6.7.2.3 The Identification of the Effect

Differences in the way the effect is identified in the retrospective and prospective questions are also relevant to the possibility of establishing legally relevant relations. Whereas the retrospective question demands a relation between a particular behaviour and some ostensively identified damage that has already occurred, the retrospective question asks for relations between the particular behaviour and damage of a certain kind. In order to establish the legally relevant relation by asking the retrospective question, there must thus be sufficient support for the existence of a relation between the behaviour and an ostensively identified effect. In order to establish it by asking the prospective question, the damage need not be identified in more detail than whatever is required to determine the legal kind to which it belongs. For example, it is relevant to the answer to the prospective question whether a disease will affect fish or human beings, but irrelevant whether it will affect human individual *a* or *b*. The retrospective question, on the other hand, explicitly scrutinizes the relation between the behaviour and a particular, ostensively identified case of damage such as individual *a's* disease.

The following example illustrates the way this difference between the two questions enables the prospective question to establish more legally relevant relations. Suppose that a disease is slightly more common in a group exposed to a particular cause than it is in an unexposed group. Let us assume that the empirical correlation here is weak irrespective of whether the relevant

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[347] Wright, "Causation in Tort Law", 1985, p. 1793.

subgroup comprises those who have been exposed to the cause or those who have been exposed to the cause *and* developed the disease. As we saw in Section 6.7.1, such a weak empirical correlation may hinder any use of the retrospective question to establish a legally relevant causal relation between the substance and the disease in a particular individual. However, the correlation may suffice to establish a causal relation between a particular exposure and the disease in *some* of the individuals which fall within the scope of the prospective question. Hence, it may allow us to establish the legally relevant causal relation by asking the prospective question.[348]

6.7.2.4 The Timing of the Question

The prospective question has a significant epistemic advantage in the way it identifies the effect, but the retrospective question has its advantages too. Because the retrospective question is asked later than the prospective question, the state of scientific knowledge available to answer it is typically better. The chance that the same kinds of cause and effect are known to be related in ways similar to the conditions in the legally relevant situations is higher, and the chance that more detailed studies have been conducted, which can result in a stronger empirical correlation, increases.

Moreover, the fact that the effect has already occurred by the time the retrospective question is asked is a relevant piece of knowledge in itself. As observed already in Section 6.6.2, this

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[348] As pointed out by Cranor, general questions, too, have this advantage as compared to retrospective questions (see Cranor, *Regulating Toxic Substances*, 1993, p. 95). Since general questions do not require that a causal relation exists between the particular behaviour and the damage, they will also escape all inferential obstacles that are due to the conditions in the particular case. The prospective question will escape those that are due to differences between the conditions obtaining in the distinct, but legally equivalent, effects that the question seeks, but not those that are relevant for the occurrence of any such effect (see Section 6.7.1 above).

information may sometimes allow for the establishment of a causal relation in the absence of any scientific knowledge describing relations between entities of the same kinds. It may also provide the additional information required to establish the legally relevant relation by applying available scientific information. In particular, the empirical correlation will typically be stronger in the sub-group whose members have been exposed to the cause *and* developed the effect than it is in the wider sub-group that includes everyone who has been exposed to the cause. Thus, even if, say, only 4% of those exposed to a particular substance have been found to develop lung cancer, such exposure may simultaneously have been found to more than double the risk for lung cancer.[349] In the example described in the section above (about the difference between the ways in which the effect is identified) the empirical correlation was assumed to be weak in both groups. In reality, however, it will often be significantly stronger in the group whose members have developed the effect. This information can be used to establish a causal relation retrospectively but not prospectively. So the retrospective question may be more effectively pursued than the prospective question in situations where it is uncertain whether conditions relevant to the existence of relations between behaviour and damage are present.

6.8 Conclusions

In this chapter we have seen that many of the relations that retrospective and prospective questions put in the foreground cannot be established through the application of scientific knowledge. Differences between legal and scientific ontology, together with nature's complexity and the fragmentary character of scientific knowledge, create significant epistemic gaps in respect of

[349] See Section 5.3.3.

these relations. Recognition of the epistemological differences between law and science, and the application of a lower standard of proof, will be of some use in efforts to close these gaps. However, the discussion has shown that many legally relevant relations remain impossible to establish even if a low standard of proof is applied. The chapter has therefore confirmed *H2*, the second hypothesis stated in Chapter 3, which claims: *ontological differences between law and science will systematically hamper efforts to establish the relations sought when retrospective and prospective questions are raised*. Legal rules presupposing that such relations are established to ensure that the counteractive responsibility they prescribe ensues will therefore be less efficient tools to counteract detrimental consequences of human behaviour than their appearance suggests. As a result, a substantial residual risk remains with the affected individuals, future generations and the environment.

We have also seen that some differences between legal questions about causation are relevant to the possibility of establishing legally relevant relations. It is generally easier to establish a legally relevant relation between particular behaviour and absolute instrumental damage than it is to establish one between particular behaviour and intrinsic damage. Furthermore, in situations where the scientifically known relation is weak and/or the legally relevant behaviour's contribution is quantitatively small, an understanding of the causal relation in terms of the NESS test allows for the establishment of more legally relevant relations than an understanding in terms of the but-for test. The prospective question is generally better than the retrospective one at establishing relations by applying known relations with weak empirical correlations. Efforts to answer the retrospective question about causation, on the other hand, will benefit from the growth of scientific knowledge and from the fact that the effect has already occurred when the question is being asked. As a result, the retrospective question will often be more successful than the prospective question in situations in which it is uncertain whether conditions of relevance to the occurrence of legally relevant effects obtain. In the next chapter, I will use these findings to examine some ways in which detrimental consequences of human behaviour can be counteracted more effectively.

7 Ontological Adaptations

7.1 Introduction

In this chapter, I examine the possibility of adapting legal ontology in response to the epistemic gaps demonstrated in the previous chapter. Section 7.2 discusses the relevance of epistemic considerations to legal ontology. Section 7.3 explains the need for a holistic assessment of ontological adaptations. Section 7.5 examines a number of ontological adaptations that can be made, in the light of epistemic gaps, to counteract the detrimental effects of human behaviour more effectively. Section 7.6 summarizes the chapter's conclusions.

7.2 The Relevance of Epistemic Considerations to Legal Ontology

In the previous chapter we saw that, in many cases, epistemic gaps make it hard to establish legally relevant relations. Clearly, this limits the efficiency of rules requiring such relations to be established. The discussion has shown that merely relaxing the standard of proof, or recognizing the epistemological differences between law and science, is of limited help in this predicament. Therefore, if the relaxation of evidential requirements is to promote

the actual imposition of the counteractive responsibility that these rules prescribe significantly, it will presumably have to involve at least partial reversal of the *burden* of proof.[350] The epistemic gaps that have been demonstrated can perhaps be used to argue, then, that some such reversals are plausible. The two inferential steps in which these gaps have been seen to arise can in that context serve to illustrate the space for, and usefulness of, partial reversals of the burden of proof. (As will be recalled, the first of these steps, discussed in Section 6.6, involves the establishment of associations between kinds, and the second, discussed in Section 6.7, the establishment of legally relevant relations between particulars.) Adaptation of the standard and burden of proof, however, is not the only possible way to promote the counteraction of detrimental consequences of human behaviour; an alternative strategy would be to adapt the legal *ontology*.

The epistemic gaps discussed in the previous chapter arise because the kinds of entity figuring in legal and scientific discourse

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[350] Discussions about existent and/or appropriate, partial or full, reversals of the burden of proof can be found in, for example, Carlsson, *Arbetsskada*, 2008, pp. 470 ff., Klami, *Law and Truth*, 2000, p. 265 and Khoury, *Uncertain Causation in Medical Liability*, 2006, pp. 77 ff. According to Govt. Bill 1985/86: 83 p. 47, the burden of proof rests on the defendant with respect to the contribution of casual (*sic*, not "causal") conditions in the causal relations required for Environmental tort liability. This may at first sight appear to imply a partial reversal of the burden of proof with respect to the second inferential step in the establishment of causal relations. However, the statement refers to casual factors *contributing* to the effects. The contribution of such factors does not exclude the existence of a causal relation according to the NESS test or the but-for test. Such contribution can instead be relevant to additional limitations of the scope of the liability (see the discussion of the requirement of "adequate causation" in Section 3.3.3.1). It should be observed, then, that this localization of the burden of proof with respect to the contribution of casual factors does not imply a relaxation with respect to the burden of establishing a "factual" causal relation between the defendant's behaviour and the damage. The last paragraph on the evidential standard in the Bill (p. 48) indicates that it has confused these issues.

are different; and because scientific knowledge is fragmentary in nature. They are thus in part a result of the scientific ontology. To say that the legal ontology should be adapted in the light of these gaps is therefore to say that the scientific ontology should be allowed to influence the legal ontology. At first sight, this may seem to violate the principle that the legal ontology should be given priority over the scientific ontology in a legal context. However, this principle implies that it is the categorizations that are most appropriate given legally relevant considerations which should be given priority in a legal context.[351] Considerations bearing upon how to *achieve* the aim of the law are certainly legally relevant. Failure to take such considerations into account risks reducing the aim of the law to an ideal and the legal rules to little more than toothless means for its achievement.[352] Epistemic considerations are obviously important in this respect. To allow considerations of epistemic gaps, due to ontological differences, to affect the legal ontology is therefore not necessarily to flout the principle that the legal ontology should be given priority in a legal context. Indeed it is a tenet underlying the arguments made in this monograph that – to a greater extent than is presently the case – such considerations should be taken into account both in the application of the law and at the level of legislation. An ontology shaped by the consideration of epistemic gaps is thus still a legal ontology, and it is a more appropriate categorization than one in which such considerations have not been taken into account.

As discussed in Chapter 4, epistemic constraints are salient in the scientific ontology. They affect not only what is, in fact, scientifically known, but also, to a large extent, what kinds of entity it is scientifically meaningful to ask questions about. Because the

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[351] See Section 2.2.

[352] See, for example, Westerlund, *Miljörättsliga grundfrågor 2.0*, 2003, pp. 95 ff. and *Fundamentals of Environmental Law Methodology*, unpublished, pp. 156 ff. and pp. 181 ff. and Gipperth, *Miljökvalitetsnormer*, 1999, pp. 10 ff.; both authors stress the importance of the "operationalisation" of legal rules. See also Gelpe, M., and Tarlock, D., "The Uses of Scientific Information in Environmental Decision-making", 1974, p. 373.

epistemic gaps that have been discussed in the previous chapters partly reflect the epistemic constraints that underlie scientific categorizations, it is tempting to conclude that the assimilation of legal to scientific categorizations is the best way to take epistemic constraints into account in a legal context, too. Such a conclusion would, however, be mistaken. Epistemic constraints are important, but they are not the only factor of relevance to legal and scientific categorizations. Due to the different aims and functions of law and science, other considerations of relevance in these contexts will differ. The influence that epistemic constraints should be accorded in a legal context, in response to legally relevant considerations, therefore need not coincide with the influence that such constraints have on scientific categorizations. For example, already the difference between legal and scientific standards of proof will affect the extent to which epistemic constraints impede the establishment of states of affairs in a legal (as compared with a scientific) context. Furthermore, considerations of relevance to legal responsibility, pertaining to, for example, morality, predictability and economy, may call for demarcations or unifications that are unmotivated in the scientific context. Hence the assimilation of legal categorizations to scientific categorizations is not a generally appropriate solution to counter the epistemic gaps to which the differences between legal and scientific ontology give rise.

Ontological adaptations made in response to epistemic difficulties are no novelty to the legal system. Rules that raise retrospective and prospective questions about causation are certainly important legal tools, but they do not exhaust the legal toolbox. Some rules, which likewise serve to counteract detrimental consequences of human behaviour, do not acknowledge the existence of a causal relation between particular behaviour and damage as being of as much importance to the imposition of counteractive responsibility. As already mentioned, certain rules impose responsibility to take measures on the basis of an established

association between behaviour and damage of certain kinds.[353] Emerging alternative forms of tort liability, such as market share liability,[354] loss of chance[355] and other kinds of proportionate liability,[356] similarly downplay the importance of establishing a causal relation between particular behaviour and damage in attributions of counteractive responsibility.[357] So does the usage of statutory, as well as voluntary, insurance solutions.[358] Already the imposition of responsibility to counteract what I have called "absolute instrumental damage" can be seen as a step in this direction. A number of rules set explicit limits which can be conceived of in terms of such damage. Whereas some of these prescribe limits to the amounts of certain substances in particular

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[353] See Section 3.2.

[354] In *Sindell v. Abbott Laboratories* (1980), the plaintiff's mother had taken the product, Diethylstilbestrol (DES), during pregnancy; as a result the plaintiff developed cancer. The court imposed liability to compensate for parts of the damage which corresponded to the defendant's market share of the kind of product that was known to have caused the cancer.

[355] See, for example, the classic case *Chaplin v. Hicks* (1911), in which the court awarded the plaintiff damages for the loss of chance of winning a beauty contest. The defendant prevented the claimant from taking part in the final stage of the contest and the damages awarded corresponded to the claimant's statistical chance of winning.

[356] See, for example, discussions in Goldberg, *Causation and Risk in the Law of Torts*, 1999, Khory, *Uncertain Causation in Medical Liability*, 2006 and European Group of Tort Law, *Principles of European Tort Law*, 2005, pp. 46 ff. See also the "Evidential Damage Doctrine" advocated by Porat and Stein (*Tort Liability under Uncertainty*, 2001, p. 1 and pp. 160 ff.), according to which evidential uncertainty created by a party should be conceived of as a legally relevant and actionable kind of damage.

[357] These are tendencies rather than clear-cut categories; thus it could be argued that, for example, liability for loss of chance maintains the causal requirement, but that it is applied to parts of the damage. (See Stapleton, "The Gist of Negligence Part II", 1988, p. 392.)

[358] For example, the claim for compensation in NJA 1982 p. 421 (discussed in Chapter 6) would today be settled within the framework of pharmaceutical drug insurance.

media, others set limits, or "caps", to the amount of a pollutant that may be emitted.

Many of these rules constitute relatively new responses to a growing awareness of the need for alternative approaches to the multifarious objects of legal regulation. Awareness of epistemic difficulties that impede the efficiency of the regulation is certainly one of the factors that have contributed to this development. For example, the imposition of proportionate tort liability is to a large extent a result of the difficulties involved in the establishment of causal relations between particular behaviour and damage. Similarly, the imposition of responsibility to prevent "absolute instrumental damage" is at least in part motivated by nature's complexity and unpredictability.[359] So recognition of epistemic difficulties has already brought new legal tools and new legal categorizations of the world.

Even so, there is no reason to assume that epistemic difficulties are now satisfactorily dealt with, or that all possible means to counter such difficulties now have been exhausted. To begin with, many of the solutions mentioned above have a restricted area of application. Most courts still look at proportionate tort liability with a good deal of scepticism and the impact that these solutions have had on the Swedish legal order is limited. The present discussion of the epistemic gaps involved in the establishment of relations between particular behaviour and damage can be used to argue that these, and other alternative approaches also, should be put to more extensive use. There may, however, be non-epistemic arguments against doing so. For example, rules that prescribe general responsibility to take preventive measures are likely to be regarded as disproportionate if the actual need for such measures is rare. Proportionate liability may be rejected *inter alia* because it leads to an

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[359] See Section 3.3.2. See also the discussion of the epistemic virtues of Environmental Quality Norms in Gipperth, *Miljökvalitetsnormer*, 1999, pp. 10 ff., and the discussion of the epistemic advantages of general, as opposed to retrospective, questions about causation in Cranor, *Regulating Toxic Substances*, 1993, p. 95.

overcompensation of plaintiffs whose damage was not caused by the responsible person's behaviour, and to the under-compensation of those whose damage was.[360] It is also important to see that many of these solutions have limited applicability in relation to the legal aim of counteracting detrimental consequences of human behaviour. So, for instance, proportionate liability is hardly meaningful in situations where the proportion of the damage that is attributable to the responsible person negligible. It may work well in contexts where there is already some salient connection between the responsible person and the party claiming damage (as happens in, for example, product liability and medical maltreatment cases). However, it seems to be a less viable solution to damage caused via our common environment, where the aetiology of the damage is often highly diffuse and stems from a very large number of actors.[361]

Finally, and perhaps most importantly, these alternative solutions too are susceptible to epistemic difficulties. Epistemic gaps that arise in the establishment of relations between kinds will reduce the efficiency of all of these tools.[362] Tools that impose proportionate liability will avoid gaps that are due to low empirical correlation in the establishment of legally relevant relations.[363] If, however, the proportion of the liability must be individualized,[364] the imposition of such liability will be hindered not only by empirical gaps in the establishment of relations between kinds, but by empirical gaps due to insufficient similarity. (It should be recalled that the existence of such gaps does not imply that no legally relevant relation exists; it implies merely that such a relation cannot be established by means

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[360] See, for example, Stapleton, "The Gist of Negligence Part II", 1988, pp. 390 f. and Goldberg, *Causation and Risk in the Law of Torts*, 1999, p. 29 and citations.

[361] Cf. Brennan, "Environmental Torts", 1993, pp. 61 ff. for a discussion of the possibility of applying proportionate liability in these situations, too.

[362] See Section 6.6 above.

[363] See Section 6.7 above.

[364] See, for example, Hill, "A lost Chance for Compensation in the Tort of Negligence by the House of Lords", 1991, pp. 511 ff.

of the available scientific knowledge.) The map of the origins of epistemic gaps sketched in the previous chapter can therefore be used to assess the epistemic vulnerability of these tools, too.

In short, then, a number of factors will constrain the extent to which these alternative tools promote the counteraction of detrimental consequences of human behaviour. The brief discussion in this section therefore suggests that there is both a need and the space for further ontological adaptations in order to promote achievement of this aim in the light of epistemic gaps. In the rest of this chapter some such adaptations will be examined.

7.3 The Need for a Holistic Approach

This chapter explores possible ontological adaptations, but it does not recommend the most appropriate adaptation. The reason for this restricted ambition is that the merits of ontological adaptations must be assessed against all legally relevant considerations. For example, these merits must be assessed in the light of other existing rules and possible adaptations within the relevant area. The relative efficiency of different kinds of responsibility in counteracting the detrimental consequences of human behaviour is one factor of relevance in this respect. Thus, different kinds of responsibility, such as prevention and compensation, are often not on a par in respect of their direct and indirect counteractive efficiency. Furthermore, whereas the consideration of epistemic constraints and the aim to counteract detrimental consequences of human behaviour may favour certain adaptations, other legally relevant considerations may point in another direction. Thus a logically possible extension of the area of legal responsibility might be discarded by some as legally inappropriate because it is regarded as morally unjustifiable, economically inefficient and/or administratively unwieldy. The short discussion in this chapter cannot take all such factors into proper account. Moreover, it will have a relatively narrow focus on the potential to adapt the use of the retrospective and prospective questions that have been discussed in this monograph. It should

therefore be seen as a contribution to, but not a conclusion of, discussions of ontological adaptations in the light of epistemic gaps.

The discussion of possible ontological adaptations in the next section is divided into four subsections. The first three examine whether the area of application of the retrospective and prospective questions, and the rules that give rise to them, can be adjusted in order to promote the counteraction of detrimental consequences of human behaviour. Section 7.4.1 examines possible adaptations based on the epistemic differences between retrospective and prospective questions. Section 7.4.2 discusses adaptations in the light of the differences between intrinsic and absolute instrumental damage, and Section 7.4.3 discusses adaptations based on contrasts between the but-for test and the NESS test. Lastly, Section 7.4.4 briefly examines the possibility of further relaxing the requirement that the damage to be counteracted is caused by the behaviour of the responsible person.

7.4 Possible Ontological Adaptations

7.4.1 The Retrospective Question and the Prospective Question

The retrospective and prospective questions can, in theory, apply to the same causal relations. However, the discussion has shown that the ways in which epistemic constraints impede the establishment of relations that these questions seek differ depending on the question raised. Although the two kinds of question can *target*, or be about, the same relations, they will thus not succeed equally well in *establishing* them. As we have seen, the prospective question typically succeeds better in establishing causal relations by means of a scientifically known relation with a weak empirical correlation. Hence the prospective question is less susceptible to difficulties which arise in the second inferential step and which are due to the weakness of the scientifically known relation. On the other hand, the retrospective question, which is asked at a later stage than the

prospective question, can benefit from growth in scientific knowledge. It can also exploit the fact that legally relevant damage is known to have actually occurred, and hence is known to instantiate a reference class where the empirical correlation, generally speaking, is stronger. Different rules, then, will let different legally relevant relations through, depending on which of these questions that they make use of.

As we saw in Chapter 3, it is not only epistemic constraints that affect the relations let through by the rules that make use of these questions. The relevant behaviour and damage differ from one legal rule to another, depending on considerations of relevance to the kinds of responsibility that the rules impose. For example, tort liability will only encompass particular kinds of damage that affect legally relevant subjects. Ecological damage, on the other hand, is relevant according to many rules that give rise to prospective questions. However, rules that impose a responsibility to take preventive measures are by definition restricted to effects that can be prevented; they are also constrained by considerations pertaining to economic possibility and efficiency.

These limitations in range of retrospective and prospective questions and the rules that give rise to them are all motivated by legally relevant considerations pertaining to the appropriate scope of the kinds of responsibility that the rules impose. Hence the areas of application of these rules and questions are limited in relation to the detrimental consequences of human behaviour that the law aims to counteract. This difference between the range of the rules and the legal aim can be criticized, or defended, by reference to factors that are independent of epistemic difficulties. However, the epistemic gaps that have been demonstrated, and the respective epistemic advantages of each of these two kinds of question, introduce additional considerations of relevance to this discussion. In particular, the question now arises whether it is reasonable to limit the prospect of establishing causal relations of relevance to the legal aim by limiting the area of application of these rules and questions in the way presently done.

The retrospective question's superiority in establishing many causal relations could, for example, be used to argue that the area of

strict liability should be further extended. The negligence requirement will often restrict the scope of the retrospective question to behaviours that could be expected to give rise to detrimental effects already at the time they were undertaken. This requirement will therefore significantly limit the possibility of making use of the increased causal knowledge that time affords. The epistemic advantages of the retrospective question could also be used to argue that the period of limitation of tort liability – presently 10 years – should be extended.[365] A longer period of limitation would allow the epistemic advantages of the retrospective question to be exploited further.

The possibility of recognizing ecological damage as a kind of damage of relevance for tort liability should likewise be reconsidered. The new regulation on Environmental Liability in Chapter 10 of the Environmental Code seems to have drawn the attention of many legal scholars away from this possibility.[366] Although this chapter of the Code recognizes pollution and some kinds of serious ecological damage, it leaves out the lion's share of effects that qualify as "damage or detriment to human health and the environment" in the Code's second chapter. The EC directive this chapter is partly based upon allows member states to impose a more far-reaching liability – a possibility Sweden has so far not made much use of.[367] Tort liability for ecological damage can provide a viable way to make use of the retrospective question's epistemic advantages with respect to damages for which the kinds of

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[365] See sec. 2, Law of Limitation (SFS 1981:130).
[366] As an example NJA 1995 p. 249 was discussed at some length in the first edition of the Swedish textbook *Den svenska miljörätten* (Michanek and Zetterberg, 2004, pp. 405 f.), which was published before the amendments of the 10th chapter. In the second edition, released after the new regulation, the case is merely used to illustrate the difficulties that were involved in counteracting such damage before the new regulation (Michanek and Zetterberg, *Den svenska miljörätten*, 2008, p. 288).
[367] Michanek and Zetterberg, *Den svenska miljörätten*, 2008, p. 271.

responsibility imposed by Chapter 10 of the Environmental Code are unsuitable.

The prospective question, on the other hand, has rather different epistemic advantages. Correspondingly, it can be called into question whether it is reasonable to restrict the area of the prospective question, and the rules that give rise to it, in the way presently done. Thus, we saw in Chapter 3 that prospective questions that arise in the application of chap. 2 secs. 3 and 7, Environmental Code, primarily seek out causal relations between activities, or measures, and damage that is preventable in an efficient (i.e. cost-beneficial) way by measures that are economically feasible for a typical company in the actual line of business. The prospective questions that occur in the application of stop rules in chap. 2 secs. 9 and 10, Environmental Code, require us to find causal relations between activities, or measures, and particularly significant damage. Causal relations between behaviour and damage which neither qualify as particularly significant nor can be prevented in a cost-benefit efficient and thus economically feasible way will fail to be picked up by these rules. Many legally relevant relations that *can* be established by means of prospective questions therefore fall beyond the scope of the rules that give rise to questions of this kind. Because some of these relations cannot be established by means of retrospective questions, and hence for epistemic reasons fall beyond the reach of rules that give rise to questions of this latter kind, this may seem a waste of legal resources.

Preventive measures will always require some knowledge. Given this, epistemic constraints do seem to place some absolute limits on the possibility of extending the scope of this kind of responsibility and hence the area of application of the prospective question. However, the requirement that such measures be economically feasible for a typical company in the actual line of business, as well as reasonable from a cost-benefit perspective, imposes significant non-epistemic constraints. It can certainly be questioned whether it is reasonable to allow – by reference to the financial margins of the line of business to which the activity belongs – predictable and preventable harm which is caused by professional

activities and for which reparation or compensation cannot be demanded retrospectively.

Moreover, some unknown detrimental consequences of human behaviour are presumably preventable by means of preventive measures targeting known consequences. Thus preventive measures can bypass some epistemic gaps which impede the reactive approach. These measures therefore possess some epistemic advantages in themselves. It follows that too little weight will typically be assigned to the benefits of preventive measures if the consequences that the measures are *known* to impede are taken into account alone. By contrast, the *costs* of such measures, on the other side of the balance, can be relatively straightforwardly assessed and are hence not generally underestimated in the same way.[368] It could therefore be argued that the possibility of unknown but preventable consequences should be taken into account in the cost-benefit assessment that preventive measures must pass – e.g. by giving the inevitable ignorance some weight in this kind of assessment.[369] This would typically lead to the imposition of responsibility to take more far-reaching preventive measures than is presently the case. Recognition of our ignorance of additional consequences could likewise be used to argue for a lowered threshold for (or an

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[368]Many have pointed out that cost-benefit assessments are inappropriate in situations marked by uncertainty; see, for example, Nilsson, "Man skall vara försiktig", 2002, p. 415 and Cox and Ricci, "Legal and Philosophical Aspects of Risk Analysis", 1989, pp. 1040 f.

[369] Nilsson has argued for a more comprehensive cost-benefit assessment in which the benefits of the *activity* are balanced against the activity's detrimental effects. This is not only a *prima facie* reasonable material requirement; it would also place some uncertainty (pertaining to the benefits of the activity) on the other side of the balance and thereby constitute a counterbalance to the risk of underestimation of the detrimental effects. Chap. 11 sec. 6, Environmental Code, contains a requirement of this kind with respect to water operations, but it does not apply to activities in general. (Nilsson, *Rättssäkerhet och miljöhänsyn*, 2002, pp. 160 ff.)

additional weight to) detrimental effects of relevance to the stop rules in chap. 2 secs. 9 and 10, Environmental Code.

In short, then, there are many ways in which the areas of application of the prospective and retrospective questions could be adapted in order to make further use of the epistemic advantages of each question. Some of these adaptations, such as extensions of the area of tort liability or the assignment of weight to ignorance in cost-benefit assessments, can presumably be made in the courts' application of the law within the framework of the present legislation, whereas others will require legislative change.

7.4.2 Intrinsic Damage and Absolute Instrumental Damage

As discussed in Chapter 3, some of the counteractive responsibility imposed by rules designed to prevent damage from occurring in the first place can be explained in terms of a legally relevant category of damage which I have called "absolute instrumental damage". As we saw in the previous chapter, the establishment of causal relations between particular behaviour and absolute instrumental damage avoids some of the epistemic gaps that impede the establishment of relations between behaviour and intrinsic damage in both the first and the second inferential steps. It is important to see, however, that the distinction between questions focusing on absolute instrumental damage and questions that focus on intrinsic damage differs in an important respect from that between retrospective and prospective questions. Whereas retrospective and prospective questions can, at least theoretically, apply to the same relations, questions about absolute instrumental damage draw attention to effects, and hence (to some extent) relations, other than those sought in questions about intrinsic damage.

Rules that make use of the notion of absolute instrumental damage maintain the causal requirement by requiring that a causal relation between the behaviour and the damage to be counteracted indeed exists. However, whereas these rules *impose responsibility* to counteract absolute instrumental damage, they *serve to* counteract

the intrinsic damage that is expected to sometimes ensue from damage of the absolute instrumental kind. Measures taken to prevent absolute instrumental damage can therefore be expected often to prevent some such intrinsic damage, too, even if it is unknown in what this intrinsic damage will consist in the particular case. (See what was said about the epistemic advantages of preventive measures in Section 7.4.1 above.) Even so, no link between the particular intrinsic damage that the measures serve to counteract and the particular behaviour of the responsible person needs to be established. Therefore, rules that impose responsibility to counteract absolute instrumental damage can be seen to involve a partial, but apparently justifiable, relaxation of the requirement that the damage to be counteracted is caused by the behaviour of the person who has a responsibility to counteract it. Unlike rules based on associations between kinds, however, rules that impose responsibility to counteract absolute instrumental damage allow circumstances that in the particular case affect the occurrence of such damage to be taken into account.

Epistemic considerations favour extensive use of the notion of absolute instrumental damage, and this category could presumably be pressed into even more extensive service within rules that give rise to prospective questions than it is today. A drawback of this kind of damage is that it is likely to be assigned less weight than damage of an intrinsic kind. This weight will affect the outcome of the cost-benefit assessment that preventive measures will undergo. A way to compensate for this, and to thereby extend the impact of the notion of absolute instrumental damage, is to assign such damage more importance, in line with what was said about the relevance of ignorance in Section 7.4.1. This could, for example, imply that further steps must be taken to prevent lower levels of contamination or pollution than those presently required.

7.4.3 The NESS Test and the But-for Test

As we have seen, it is generally easier to establish a causal relation between behaviour and damage if we understand the legally relevant relation in terms of the NESS test rather than the but-for

test. Whereas the NESS test is of little help in the first inferential step, which involves the establishment of an association between kinds, its advantages are significant in the second inferential step, which involves establishment of a legally relevant relation. *Ceteris paribus*, then, the NESS test is preferable to the but-for test. However, like the difference between absolute instrumental damage and intrinsic damage, the distinction between the NESS test and the but-for test is qualitatively different from the distinction between the prospective and the retrospective questions. Questions seeking causal relations via the NESS test require us to look for relations somewhat different from those targeted by similar questions linked with the but-for test. A factor can sometimes qualify as a cause with respect to a particular case of damage on the NESS test even if the damage in question would have occurred also in the absence of that factor and hence would not qualify under the but-for test. And, if the world is indeterministic, some factors which qualify as causes according to the but-for test will not do so according to the NESS test.[370] On the other hand, many factors – and hence many relations – will qualify as causes and causal relations according to both tests. The extensions of these differing notions of a legally relevant causal relation will therefore, according to these tests, overlap to a large extent.

Whether the NESS test indeed is preferable depends on what other considerations favour each of the two tests. If those other considerations are of equal importance, epistemic considerations will normally be decisive in favour of the NESS test. The same thing will happen if the strength of the epistemic consideration in favour of the NESS test outweighs a hypothetical balance of other considerations in favour of the but-for test. However, whether or not they favour the but-for test or the NESS test, those who insist that the "true" nature of causation *alone* should determine the legal understanding of causation will not accept epistemic considerations as relevant. Yet, it is hard to see why the content of the legal requirement of causation would be immune to epistemic considerations in a way that other

[370] See the discussion in Section 3.3.3.1, note 195.

legally relevant categories are not. To begin with, and as discussed in Section 3.3.3.1, neither of these tests seems to express the "true" nature of causation; they seem rather, at most, to capture more or less legally appropriate ways to conceive of when such a relation obtains. Their function is thus partly instrumental already. Furthermore, epistemic considerations may very well make the adoption of, for example, the NESS test reasonable even if the relation of utmost legal relevance is understood in terms of the but-for test. Thus because the extensions of the two understandings largely overlap, adoption of the NESS test can actually enable the establishment of *more* causal relations in the but-for sense than adoption of the but-for test would do.

As we saw in Chapter 3, the meaning of the legal requirement of causation is not specified in Swedish law. The NESS test is already – that is to say, without the support of epistemic considerations – an important candidate explanation both of this requirement and some of the ways in which it has actually been applied. Presumably, then, the NESS test can be put to extensive use within the existing regulation without violating the legal requirement of predictability. It should, however, be pointed out that much present discussion of the choice between the but-for test and the NESS test is concerned with the conceptual boundary between causal issues, on the one hand, and issues of policy, on the other, and hence is not necessarily relevant to the boundaries of the scope of legal responsibility. Most advocates of the NESS test admit that the but-for test can play an important role as a non-causal requirement for legal responsibility. To the extent that the but-for test remains as a requirement for legal responsibility, epistemic gaps which can be avoided in the causal assessment by adoption of the NESS test will instead return in the policy-based assessment of the scope of the responsibility. The relevance of considerations pertaining to epistemic gaps (discussed in the previous chapter) is not, therefore, restricted to the requirement of causation.

7.4.4 Relaxing the Causal Requirement

As has already been said, the rules discussed above typically impose responsibility to counteract effects caused by the behaviour of the person to whom responsibility is being attributed. The legal relevance of a causal relation between such behaviour and the damage to be counteracted is, as we have seen, largely due to considerations pertaining to morality and efficiency. Yet, causal requirements of this kind have sometimes been thought to lead to unwanted consequences. For example, causal requirements understood in terms of the but-for test seem to restrict the area of accountability in unwelcome ways. The philosophical and legal literature is rich in discussions of situations in which accountability appears appropriate despite the fact that the effect was causally overdetermined, meaning that nobody's behaviour was necessary for the effect in the sense of the but-for test.[371] The collective emission of greenhouse gases, the bombings of Dresden, and two murderers' simultaneous and individually lethal shots of the same victim, are just a few commonly quoted examples in which it at least is problematic to claim that there is a causal relation between the individual actions and the harm in the sense given by the but-for test.[372] Thus, if legal responsibility requires that test to be passed, the result may be that nobody can be held accountable in these situations. It should be observed that this restriction of the area of accountability often is conceived of as being due to the *actual lack of* a

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[371] See, for example, Hellner and Radetzki, *Skadeståndsrätt*, 2010, pp. 214 ff., Kutz, *Complicity*, 2000, pp. 117 ff., Stapleton, "Unpacking Causation", 2001, pp. 174 ff. and Wright, "Causation in Tort Law", 1985, pp. 1775 f.

[372] There have been attempts to save the but-for test in these situations by way of fine distinctions between different effects: see, for example, Lewis "Causation as Influence", 2000, pp. 185 ff. and Mackie, *The Cement of the Universe*, 1980, pp. 45 ff. As already mentioned in note 343 above, this kind of approach has been criticized by Hart and Honoré (*Causation in the Law*, 2002 (1985), pp. xli f.) and Wright ("Causation in Tort Law", 1985, pp. 1778 ff.). Cf. Adams, "The Flexibility of Description and NESS Causation", 2010, however, for criticism of this criticism.

causal relation in the sense of the but-for test, and hence independent of the *epistemic constraints* that have been discussed in this monograph.[373]

Lack of responsibility in situations of this kind is often unsatisfactory. Consequently, many legal scholars and philosophers have tried to devise alternatives to the but-for test as bases for accountability. One such is to adopt an alternative understanding of *causation*. Thus, as discussed in Chapter 3, the NESS test does not seem to preclude causation in situations marked by overdetermination and many have argued that it should replace the but-for test. If the NESS test is adopted, responsibility can thus be imposed in such situations while retaining the causal requirement. Others have instead claimed that refinement of the causal notion is the wrong way to solve the question of moral accountability, and that the causal requirement should simply be abandoned. Thus, Christopher Kutz has recently argued that individual participation, rather than causation, should constitute the basis for moral accountability.[374] He contrasts the commonly embraced "Individual Difference Principle", according to which one is responsible only for the difference one's action alone makes to the resulting state of affairs, with the, in his view, preferable "Complicity Principle", according to which one is responsible for the harm or wrong oneself and others do together, independently of the actual difference one makes.[375]

The arguments just mentioned all claim that the existence of a relation in the but-for test sense is inessential to moral and legal accountability. These arguments are thus not primarily motivated by epistemic considerations. Even so, metaphysical and/or moral arguments of these kinds can work together with epistemic considerations to support alternative grounds for legal responsibility. Thus, the NESS test's epistemic advantages can,

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[373] To the extent that modifications of the but-for test can account for these situations it will instead turn into an epistemic problem.

[374] Kutz, *Complicity*, 2000, pp. 67 ff. and p. 113.

[375] Kutz, *Complicity*, 2000, p. 116.

together with non-epistemic considerations that favour it, provide a strong case for adopting that test, rather than the but-for test, as legal confirmation of causation. However, despite the relative epistemic advantages, causal relations established by the NESS test fall prey to some epistemic gaps which may threaten the efficiency of rules presupposing that such relations can be established. If the causal requirement, in line with Kutz's proposal, is instead relaxed, the threat that epistemic gaps pose to the legal aim of counteracting detrimental consequences of human behaviour can be expected, typically at any rate, to decrease accordingly. As we have seen, some rules already do this.[376] The discovery of non-causal grounds for moral accountability can perhaps allow for further steps in this direction.

Comprehensive discussion of the possibility of relaxing the requirement of causation within existing kinds of counteractive responsibility cannot be undertaken in this monograph. Instead I will content myself with three remarks that are relevant to such a discussion. The first of these is that the epistemic gaps demonstrated here, and the inferential steps in which these gaps arise, can serve to illustrate the space for, and usefulness of, causal (as well as evidential) relaxations.[377] Secondly, it should be pointed out that even if causation is inessential to accountability, it may nevertheless be seen as important in the justification of certain kinds of counteractive responsibility. The fact that some kinds of counteractive responsibility can be justified despite the absence of a causal relation between particulars does not imply, then, that all can be thus justified.

Last, but not least, there is no reason to assume that *existing* kinds of counteractive responsibility exhaust all *possible* kinds of counteractive responsibility. Rather than just modifying existing legal tools in the light of the constraints imposed, or offered, by our scientific knowledge, we ought to look at the problem the other way

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[376] See Sections 3.2.2 and 7.2.

[377] See Section 7.2 above.

round and ask how we can achieve the *aim* that these tools serve using the knowledge that science can provide. Modifications of existing tools and their scope is certainly one way to do this, but the construction of alternative tools with other, novel kinds of responsibility is another interesting option.

I would like, finally, to mention one example of such an alternative and supplementary kind of responsibility which I think is worthy of further examination. What I have in mind, is the use of an environmental fund to which operators under certain conditions must contribute, which can be used to finance measures to counteract detrimental consequences of human behaviour. Two earlier variants of such a fund in the Environmental Code have recently been abolished following their marginal actual usage.[378] Environmental funds can, however, take various different forms, and the fact that some of them have failed (and because of the way that they were constructed were deemed to do so) should not be used as an excuse to abandon the concept. Let me therefore just mention some benefits of this kind of counteractive responsibility, referring to the problems that have been discussed in the previous chapter.

The discussion has shown that science provides us with knowledge of relevance to the legal aim that the present regulation does not make any use of. Thus, the present regulation lets much damage through, despite the fact that this damage is known to be caused by human behaviour and is of a kind that the law can reasonably be seen as aiming to counteract. For example, the law does generally not impose responsibility to take preventive measures that are economically very demanding and the requirements it raises are normally limited to measures that appear to be efficient in a cost-benefit balancing. Nor does the law impose responsibility to repair ecological damage that does not qualify as "serious". Hence, the present regulation allows human behaviour to knowingly cause

[378] Govt. Bill 2008/09: 217 p. 10. (Chapter 33, Environmental Code, on Environmental damage insurance and Environmental clean-up insurance expired on the 1st of January 2010.)

much legally relevant damage "for free". This surplus of scientific knowledge, which certainly seems to warrant *some* counteractive responsibility, but at present does not trigger any such responsibility, could easily justify payments to a fund. Because the weight of this kind of responsibility is easy to adjust, the causal link required to trigger some responsibility of this kind need not be very strong. In relaxing the causal requirement with respect to the relation between particular behaviour and particular intrinsic damage, this kind of responsibility also avoids many of the epistemic gaps that impede impositions of responsibility of other kinds. The fund itself can be used to finance both reactive and proactive measures to counteract detrimental consequences of human behaviour. Examples of such measures are the clearing of polluted areas, liming, the construction of wetlands and research on green chemistry. These measures do not in themselves presuppose that a causal relation between the damage to be counteracted and the behaviour of a particular person has been established. Instead they are constrained by the often high costs that they involve and the lack of funding to carry them out.

It is also interesting to observe that the fact that the compensation is to be paid to a fund allows us to put an alternative and epistemically superior kind of retrospective question to use. The question I have in mind here is: *What damage, if any, did this behaviour cause?* Here the effect (as happens in the prospective question) is identified, not ostensively, but in terms of its affiliation to a legally relevant kind. The environmental fund makes this question possible because it can impose responsibility retroactively[379] without requiring the establishment of a causal relation between a particular behaviour and ostensively identified damage that has affected a particular person. Moreover, because the question is retrospective, but at the same time – like the prospective question – identifies

[379] Such a retroactive imposition of responsibility can be criticized for other reasons; the merits of this option too must therefore be assessed against *all* legally relevant considerations (see Section 7.3).

damage by describing it at a low level of detail, it can unite the epistemic advantages of the retrospective and prospective questions.

7.5 Conclusions

In this chapter I have discussed some ontological adaptations which, in the light of the epistemic gaps demonstrated in Chapter 6, might be used to promote the counteraction of detrimental consequences. Given that epistemic considerations are in themselves legally relevant, such adaptations are compatible with the principle that the legal ontology should be given priority in a legal context. The adaptations discussed in this chapter relate mainly to the retrospective and prospective questions. In particular, the chapter has examined the possibility of extending the area of application of rules that give rise to each of these two kinds of question, the possibility of making even more extensive use of the category of absolute instrumental damage, and the possibility of replacing the but-for test with the NESS test. I have also briefly discussed the possibility of relaxing the causal requirement. As was stressed in Section 7.3, the appropriateness of these adaptations must be measured in a holistic assessment in which all legally relevant considerations are taken into account. Such a comprehensive assessment could not be made within the framework of this chapter. Whether the adaptations proposed here, or other adaptations, are indeed appropriate given all legally relevant considerations is therefore a question that must be left for others to discuss. Even so, the discussion shows that there is plenty of room for ontological adaptations, and that epistemic gaps, if recognized and taken into account, need not present as large a risk to the public, and to the environment, as they presently do.

8 Summary and Concluding Remarks

This monograph has examined the relationship between scientific information and legal questions. A framework for the analysis of this issue was presented in Chapter 1. This framework – the EOD framework – recognizes, and makes a distinction between, *epistemological* and *ontological differences* between legal and scientific questions about the world. Whereas epistemological differences relate to the standards of proof that are used to make inferences about the world, ontological differences are differences in the way the world is categorized, and hence between what kinds of entity are recognized. Differences of these two kinds are a result of the different considerations that are relevant in legal, as compared with scientific, contexts. Legal standards of proof and categorizations should be given priority in a legal context, where the legally relevant considerations apply. Consequently, scientific conclusions about scientifically relevant entities, reached by means of scientific standards of proof, are not necessarily relevant in a legal context but need to be reassessed in the light of these differences.

The EOD framework should be of rather general use in understanding the meeting of law and science. Presumably, it can be applied to many other interdisciplinary boundaries, too. In this monograph, the EOD framework has been used to analyze the possibility of establishing legally relevant states of affairs through the application of scientific information. More precisely, I have investigated some ways in which ontological differences between law and science give rise to *epistemic gaps* with respect to legally

relevant causal relations, and I have asked to what extent recognition of epistemological differences and application of legal standards of proof can be expected to mitigate these gaps. The result of this investigation has legal relevance, since these epistemic gaps limit the efficiency of rules whose consequences presuppose that such relations have been established.

Chapter 2 explained the legal ontology's relativity to legally relevant considerations. Legal rules are typically communicated verbally and interpretation of the linguistic representations of legal ontology is therefore itself relevant to the content of this ontology. The legal importance of predictability will often – but not always – favour an interpretation of these representations according with ordinary language. However, it should be observed that it is not ordinary language as such which is of relevance in this respect but the underlying predictability. Predictability is, in its turn, only one of a number of considerations (relating to morality, economics, efficiency, and so on) which together shape legal categorizations. Ordinary language is therefore at best an unreliable guide to legal ontology, whose distinctness and theory-relativity must, therefore, be appropriately appreciated.

Considerations of legal relevance will generally differ from considerations of scientific relevance. Legal and scientific ontology can therefore be expected to differ substantially with respect to both the kinds and the individuals that they recognize. These ontological differences reflect differences between *what* in the world is of interest in the light of these different underlying considerations. From here, it follows rather straightforwardly that it is the legal ontology which should be given priority in a legal context. As has been explained, this does not imply that science and scientific findings are irrelevant to the law or to the content of the legal ontology. There is, however, no reason to assume in advance that scientific categorizations offer the best way to take account of legally relevant considerations.

Chapter 3 presented an aim of the law and two legal questions. The aim, which was said to underlie large parts of legal regulation, was characterized as the *counteraction of detrimental consequences of human behaviour*. The present investigation has been concerned primarily with this aim insofar as it relates to detrimental impacts on

human health and the environment. Many rules serving this aim impose counteractive responsibility, linking that responsibility with the obtaining of causal relations between the particular behaviour for which a subject can be held responsible, on the one hand, and the particular damage to be counteracted, on the other. Depending on whether these rules have a rectificatory or preventive function, they give rise to the question "*Did this behaviour cause the damage?*" or to the question "*What damage, if any, will this behaviour cause?*" Both of these questions direct us to seek causal relations between particular instances of legally relevant behaviour and damage. The chapter presented two familiar ways to conceive of these legally relevant relations: the but-for test and the NESS test. According to the but-for test, a causal relation exists if the damage would not have occurred but for the behaviour. According to the NESS-test, the behaviour (or parts of it) must have been a necessary element of a set which was sufficient for the effect to occur. Almost regardless of how, more precisely, the relation is conceived, its existence will depend on a potentially very large number of both positive and negative factors.

Just what behaviour and damage is relevant, according to a particular rule, will depend on considerations of relevance to the kind of responsibility that the rule imposes. Behaviour and damage that are relevant according to a given rule will thus be sufficiently homogeneous in the light of such considerations to warrant being subjected to the same kind of responsibility. Even so, the behaviour and damage here will often be highly heterogeneous in the light of non-legal considerations. From a non-legal perspective, the two legal questions and the aim that they serve are thus directed upon a variety of human behaviour and damage. In addition to damage that the law ultimately aims to counteract, some rules impose responsibility to counteract effects that do not qualify as such "intrinsic" damage and are more appropriately referred to as what I have called "absolute instrumental damage".

In the concluding section of Chapter 3, the following two hypotheses were formulated:

- *(H1) The entities that the two legal questions are about differ from scientifically known entities*

- *(H2) these differences will systematically hamper efforts to establish the relations sought when questions of the two sorts are raised*

Chapter 4 then provided a characterization of the entities that much of the scientific information that can be used to answer legal questions about causation is about. Causal heterogeneity with respect to relevant effects was said to be one factor of importance to scientific distinctions. Because the causal homogeneity of the world has revealed itself largely at the micro-level, many scientific categorizations are fine-grained. However, many phenomena cannot – at least, at present – be explained in terms of these micro-level entities. Many scientific kinds therefore include macro-level entities which often are known to be somewhat causally heterogeneous but are nevertheless explanatorily fruitful. There is therefore a multitude of partly overlapping scientific kinds at different levels, the majority of which can be expected to be non-redundant elements of the explanations that science at present provides. Despite its richness, this scientific image of causally relevant kinds cannot be expected to capture the world's entire causal structure.

Science makes use of certain strategies in seeking information of causal relations in the world. One such strategy is to study effects that occur in isolation. Another is to study effects that occur in groups. These strategies not only make information about causation possible, but affect what relations become scientifically known. Many scientifically known relations are therefore relations that occur in isolation and/or in groups. Just as our scientific information of explanatorily relevant kinds is fragmentary, so too is our information of the relations that hold between instances of these kinds.

Chapter 5 compared entities of legal and scientific relevance on the basis of the characterizations of these entities that were provided in Chapters 3 and 4. The discussion confirmed that, because of differences in underlying considerations, the legal and scientific categorizations that demarcate these entities differ with respect to both the kinds and the individuals that they recognize. More precisely, legally relevant causes and effects contain scientific entities as parts, but generally these scientifically known parts cannot

account for the full causal capacity of the legal entities. The causal relations that the legal questions focus upon, which occur between particulars in a natural (non-isolated) context, can be referred to another kind than many of the scientifically known relations and are generally relations other than those that are scientifically known. The support that a scientifically known relation provides for the existence of a legally relevant relation was said to depend on the *similarity* between the relations and – where the former occurs in a group – its *empirical correlation* with relations in a relevant sub-group's members.

Drawing on Chapters 3 and 4, the discussion in Chapter 5 confirmed *H1*. An important question in the subsequent chapter's assessment of *H2* was then stated as follows: *What obstacles hinder the establishment of legally relevant relations between legally relevant entities through the application of scientific information relating to* ***other*** *relations between* ***parts*** *of these entities?*

Chapter 6 looked at a number of obstacles to efforts to establish legally relevant relations by applying scientific information. It initially pointed out the relevance of epistemological differences and legal standards of proof in this connection, as well as the possible relevance of differences between the legal questions. The relevant legal standard of proof was interpreted as being a relatively low standard which nevertheless requires some support to be provided for the existence of a legally relevant relation. Four differences between the questions were brought forward as potentially relevant. These were the difference between intrinsic damage and absolute instrumental damage, the difference between the NESS test and the but-for test, the difference between the ways in which retrospective and prospective questions identify effects, and the difference between the points in time at which retrospective and prospective questions are asked.

The chapter also distinguished between two inferential steps in the establishment of legally relevant relations. The first of these involves the establishment of an association between kinds that the legally relevant behaviour and damage instantiate. The second involves the establishment of a legally relevant relation between the instantiating particulars. The discussion showed that the

establishment of many legally relevant relations can be expected to fail due to failure to conduct one or both of these inferential steps. Differences between legal and scientific knowledge will, together with nature's complexity and the fragmentary character of scientific knowledge, therefore create significant epistemic gaps with respect to many legally relevant relations. The application of a low standard of proof can close these gaps somewhat, but unless the burden of proof is reversed, many legally relevant relations will remain impossible to establish despite the application of a low standard of proof. This discussion therefore confirmed *H2*. Legal rules presupposing that the relations between particulars in a natural context are established for the counteractive responsibility that they prescribe to ensue are therefore less efficient tools to counteract detrimental consequences of human behaviour than their appearance suggests. To the extent that the first inferential step cannot be conducted, this is also true of rules whose consequences presuppose the establishment of associations between kinds. These rules consequently place a large risk for such consequences on present and future generations, and on the environment. The discussion also showed some differences between the legal questions in this connection. It is generally easier to establish relations where the damage is of an absolute instrumental kind than it is where the damage intrinsic. Application of the NESS-test instead of the but-for test will in some situations facilitate the second inferential step. Because of the way it identifies the effect, the prospective question will enable the establishment of relations where the empirical correlation is low. On the other hand, the fact that the effect is known to have occurred when the retrospective question is being asked will typically make a sub-group with a higher empirical correlation relevant. Furthermore, because the retrospective question is asked at a later point in time than the retrospective question, efforts to answer it will benefit from the growth of scientific knowledge.

Chapter 7 examined some of the ways in which the legal ontology could be adapted, in the light of the preceding discussion, so as to improve law-based counteraction of detrimental consequences of human behaviour. The possibility of achieving this aim of the law, given epistemic difficulties, was pointed out as a

legally relevant consideration in itself. Therefore, efforts to adapt ontology in response to epistemic gaps that arise as the result of differences between legal and scientific ontology do not violate the principle that the legal ontology should be given priority in a legal context. Some existing alternative legal tools, which have in part resulted from the recognition of epistemic difficulties, were discussed, and the remaining need for further adaptations was explained.

The chapter then investigated the possibility of extending the area of application of the retrospective and prospective questions so as to exploit further the epistemic advantages of each of the questions. It also examined the possibility of making further use of the category "absolute instrumental damage" and of the NESS test. Finally, it discussed the possibility of relaxing the causal requirement, and of pressing new kinds of counteractive responsibility into service. It was stressed that the appropriateness of these adaptations must be assessed within a more holistic framework in which all legally relevant considerations are taken into account. Even so, the adaptations examined in the chapter suggest that the risk placed on present and future generations, and on the environment, need not be as great as it is at present.

Taken as a whole, the discussion has shown that the EOD framework is a productive one in which to set the meeting of law and science. It helps us to understand the legal relevance of scientific knowledge, and it is a useful tool for examining the scope and impact of epistemic difficulties and the actual efficiency of legal rules. In general, relaxations of standards of proof, while valuable, are in themselves insufficient means to deal with epistemic difficulties. These difficulties must therefore be taken into proper account already in the design of the rules as such. The need to do this has been recognized, and indeed pointed out, by others before now, and to an extent it has already had an impact on legal regulation. However, the discussion suggests that further steps in this direction can and must be taken.

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