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EXPERT EVIDENCE, "NAKED STATISTICS" AND STANDARDS OF PROOF

In the context of the UK Supreme Court decision in Sienkiewicz v Greif (2011) this article discusses the question whether so-called *"naked* statistical *evidence"* can satisfy the civil standard of proof in English law, the *"balance* of *probabilities"*. It argues that what is required to satisfy the standard is a judicial belief that causation is more likely than not, rather than a categorical belief that causation occurred. Whether such a belief is justified depends on the weight of the evidence as well as the degree of probability it purports to establish, but there is no reason of principle why epidemiological evidence alone should not satisfy this standard.

I. Introduction

Unlike some European legal systems, English law applies sharply different standards of proof to criminal and civil proceedings.[1] In a series of recent decisions the UK Supreme Court and its predecessor the House of Lords have reiterated that there are two, and only two, standards of proof in English law.[2] The criminal standard (which also applies to certain civil matters, not relevant here) requires the judge or jury to be satisfied beyond reasonable doubt or, as juries are usually instructed, to be "sure" of guilt. The civil standard (which also applies to certain criminal matters where the defence bears the burden of proof) requires the judge or jury (though juries are rare in civil cases) to be satisfied on the balance of probabilities. In the words of Lord Nicholls, "The balance of probability standard means that a court is satisfied an event occurred if the court considers that, on the evidence, the occurrence of the event was more likely than not."[3]

This article is concerned with relation between scientific evidence that an event, or a causal connection between events, is more likely than not to have, and a legal finding that it occurred. There are two distinct issues that complicate the relation between these two kinds of probabilistic finding. One concerns the relation between an expert's conclusions about

[1] Kevin M. Clermont and Emily Sherwin, "A Comparative View of Standards of Proof" 50 American Journal of Comparative Law (2002), pp. 243 et sqq.

[2] Secretary of State for the Home Department v. Rehman [2001] UKHL 47; Re D [2008] UKHL 33; Re B (Children) (Sexual Abuse: Standard of Proof) [2008] UKHL 35; In Re S-B (Children) (Care Proceedings: Standard of Proof) [2009] UKSC 17. All 21st-century judgments cited in this article are available on the internet at <www.bailii.org> (last accessed 15 July 2013).

[3] Re H (Minors) (Sexual Abuse: Standard of Proof) [1996] AC 568 at 586.

probability and the court's degree of confidence in that conclusion; the other concerns the relation between probabilities applicable to a class of events and the probability of causation in an individual case. Despite these difficulties, I shall argue that Lord Nicholls' definition of the standard of proof – endorsed by a unanimous Supreme Court[4] – should be taken at face value, at least where questions of causation are concerned, and consequently proof of liability by so-called "naked statistical evidence" is acceptable. A piece of evidence may be considered "nakedly statistical when it applies to a case by affiliating that case to a general category of cases".[5] In this broad and perhaps misleading sense of the term, epidemiological evidence is "nakedly statistical" even if it relies on biology as well as statistics to establish causation,[6] so long as that biological evidence applies to a class of cases rather than to the individual case at hand. I do not propose to discuss what combination of statistics and biology should suffice to prove causation. I assume that statistics of relative risk, comparing those exposed and not exposed to some toxic substance with respect to the incidence of some disease, may contribute to proving causation[7] provided that good reasons exist for interpreting the statistical association as causal.[8] In denying that such an inference is objectionable on grounds of legal principle, I reject the views of several UK Supreme Court justices in Sienkiewicz v Greif.[9] Those views had no direct bearing on the actual decision in Sienkiewicz, which concerned the application of a special rule about tort liability for mesothelioma, but rather strangely, this case in which no epidemiological evidence was heard was the occasion for extensive judicial discussion of the relation between epidemiology and law.

These two arguments are dealt with in sections III and IV below. Before we reach them, Section II will further consider the nature of the evidential "gap" between what Gold,[10] in

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[4] Re D, supra note 2, at para. 23.

[5] Alex Stein, Foundations of Evidence Law (Oxford: Oxford University Press, 2005), p. 43.

[6] Cf. Claire McIvor, "Debunking Some Judicial Myths about Epidemiology and its Relevance to UK Tort Law" Medical Law Review (2013), pp. 553 et sqq. at p. 568.

[7] Alex Broadbent, "Epidemiological Evidence in Proof of Specific Causation" 17 Legal Theory (2011) pp. 237 et sqq.

[8] Carl F. Cranor, Toxic Torts: Science, Law and the Possibility of Justice (Cambridge: Cambrige University Press, 2006) at pp. 102-5.

[9] Sienkiewicz v. Greif (UK) Ltd., Willmore v Knowsley Metropolitan Borough Council [2011] UKSC 10.

[10] Steve Gold, "Causation in Toxic Torts: Burdens of Proof, Standards of Persuasion and Statistical Evidence", 96 Yale Law Journal (1986) pp. 376 et sqq.

terminology echoed by other commentators[11] and the Supreme Court,[12] calls "fact probability" and "belief probability". These terms are somewhat ambiguous, and translating them into categories of probability familiar to non-lawyers is not a straightforward task.

II "Fact" and "Belief"

Gold's discussion of "fact" and "belief" probability alludes to Hacking's discussion of the "Janus-faced" concept of probability which first emerged in the 17th century: "On the one side it is statistical, concerning itself with stochastic laws of chance processes. On the other side it is epistemological, dedicated to assessing reasonable degrees of belief in propositions [which may be] quite devoid of statistical background."[13] It seems, then, that he is adding yet another pair of terms to the succession that Hacking chronicles, for what in Mellor's terminology (also used by Hacking)[14] are called "chances" and "epistemic probabilities".[15] He also seems to use "belief probability" to refer to what Mellor calls "credences", that is psychological facts about the degree to which someone (in this case a judge or jury) actually believes a proposition, as opposed to the degree to which the evidence justifies them in believing it (Mellor's "epistemic probability").

It is difficult to be sure what view Gold – or Lord Rodgers and Baroness Hale when they draw on his views in Sienkiewicz[16] – takes of what David Lewis called the "Principal Principle",[17] or as Mellor formulates it, the chances-as-evidence principle: "A's epistemic probability, given only that A has chance p of being true, is also p".[18] This principle can be

[11] Chris Miller, "Causation in Personal Injury: Legal or Epidemiological Common Sense?" 26 Legal Studies (2006) pp. 544 et sqq.; McIvor, "Debunking", supra note 6, pp. 553 et sq.; Sarah Fulham-McQuillan "Judicial Belief in Statistics as Fact: Loss of Chance in Ireland and England" 30 Professional Negligence (2014) pp. 9 et sqq.

[12] Sienkiewicz, supra note 10, at paras. 156, 194, 217-222,

[13] Ian Hacking, The Emergence of Probability (2nd ed., Cambridge: Cambridge University Press, 2006) at p. 12.

[14] Ibid.

[15] Hugh Mellor, Probability: A Philosophical Introduction (London: Routledge, 2007) at pp. 11-14.

[16] See supra , note 10 at paras. 156, 170

[17] David Lewis, "A Subjectivist's Guide to Objective Chance" in William L. Harper, Robert Stalnaker and Glenn Pearce (eds.) Ifs: Conditionals, Belief, Decision, Chance and Time (Dordrecht: Reidel, 1981) pp. 267 et sqq. at p. 270

[18] Mellor, Probability, supra note 16, at p. 86.

used not only to predict events but to "postdict" them – which is what epidemiological evidence of causation seeks to do. To use David Kaye's example, if two cards are to be dealt face down from the top of a well-shuffled pack, the chance that both will be red is 0.25, and so is the epistemic probability. When the cards have been dealt but are still face down, the chance that both are red is either 1 or 0, but in the absence of any new evidence the epistemic probability of two red cards is still 0.25.[19] Gold, however, appears to deny that any valid inference can be drawn "from an established fact about a population to a conclusion about a particular [case]".[20] Gold is certainly not alone in taking such a view; for example it is shared by the influential tort scholar Richard Wright.[21] Wright's view, discussed in Section IV below, assumes that the kind of belief that is necessary to find a case proved is qualitatively different from a statement of subjective probability – it involves taking the fact in question to be true, not merely taking it as having a certain probability of being true. Since Gold writes that "[s]tandards of persuasion", which he equates with belief probabilities, "are most appropriately thought about as probability in the subjectivist sense,"[22] it is hard to understand why such subjective probabilities cannot be validly derived from chances applicable to populations.

David Barnes offers a clearer account of the difference between "fact" and "belief probability".[23] For Barnes, "The fact probability is the likelihood that the defendant's actions led to the adverse outcome."[24] If we accept Lewis's view that "[w]hat's past is no longer chancy,"[25] this likelihood must be not a chance but an epistemic probability, that is, a purportedly objective statement of the likelihood of a past event given certain evidence. That epistemic probability may be equal to a past chance in accordance with the Principal Principle.

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[19] David Kaye. "The Laws of Probability and the Law of the Land" 47 University of Chicago Law Review (1979) pp. 34 et sqq. at p. 39.

[20] Gold, "Causation", supra note 11 at p. 383.

[21] Richard H. Wright, "Causation, Responsibility, Risk, Probability, Naked Statistics, and Proof: Pruning the Bramble Bush by Clarifying the Concepts" 76 Iowa Law Review (1988) pp. 1001 et sqq. at pp. 1063-4.

[22] Gold, "Causation", supra note 11, at p. 382.

[23] David W. Barnes, "Too Many Probabilities: Statistical Evidence of Tort Causation" 64 Law and Contemporary Problems (2001), pp. 191 et sqq.

[24] ibid. at p. 192.

[25] Lewis, "Subjectivist's Guide", supra note 18 at pp. 266-7. Lewis's view has been challenged: see Kevin Nelson, "On Background: Using Two-Argument Chance" 166 Synthese (2009) pp. 165 et sqq. at pp. 176-8

On the other hand, "The belief probability refers to the credibility—the believability—of the evidence in support of a party's factual claims. In tort causation, the belief probability describes the factfinder's confidence in a party's evidence about cause."[26] This will typically consist, wholly or in part, of expert evidence. The next section considers some of the factors that affect a court's confidence in an expert and how these relate to judgments of probability.

III Epistemic authority and expert evidence

When a judge or jury accepts an expert's evidence, this may be because they have considered for themselves all the data and reasoning on which the expert relies and have arrived at the same conclusion. It is more likely, however, that their acceptance of the expert's evidence will be at least in part, a manifestation of epistemic deference. Epistemic deference is a legitimate and important way of acquiring knowledge. If I want to know the bearing that a certain body of evidence has on the probability of some event, and if there is an expert who has access to that evidence and knows how to determine its bearing on the probability of that event, it seems reasonable that I should defer to the expert's assessment of the evidence rather than trying to assess the evidence independently. That is, I should treat the expert as an epistemic authority.[27] To be justified in deferring to the purported expert, I must have evidence that she or he really has examined the relevant evidence, understands its epistemic bearing on the relevant matter and is testifying honestly and impartially. My confidence in the expert's assessment of the evidence (my "belief probability") should depend upon the strength of my evidence that the expert is likely to be right, together with the intrinsic persuasiveness of the expert's arguments.

A stronger form of epistemic deference is possible, in which I trust the authority to reach better judgments than I could within a certain domain, and simply adopt the authority's beliefs as my own. If I defer to an authority in this strong sense, I do not treat the authority's opinion as evidence to be weighed in forming my beliefs. Rather, "I let the other person stand in for me in my attempt to get the truth".[28] In adopting the authority's beliefs, I trust that he or she has adequate evidence to justify them. In a legal context it is generally highly inappropriate for the factfinder to let another person "stand in" for them,[29] but it might be acceptable where

[26] Barnes, "Too Many Probabilities", supra note 24, p. 192.

[27] Linda Trinkaus Zagzebski, Epistemic Authority (Oxford: Oxford University Press, 2012).

[28] Ibid. at p. 105.

[29] The classic statements of this principle are Davie v Edinburgh Corporation 1953 SLT 54 and R v Turner [1975] QB 834.

the parties in civil proceedings have appointed a single joint expert and neither party wishes to challenge the expert's findings.[30] "In such circumstances", according to Lord Justice Clarke, "it is difficult to envisage a case in which it would be appropriate to decide this case on the basis that the expert's opinion was wrong."[31] It is unnecessary to treat the expert's opinion as a piece of evidence to be weighed against other evidence, because there is no other evidence to weigh it against. The result is that in many relatively minor civil cases, the single joint expert "in effect becomes the judge".[32] Where there is other evidence, the expert's opinion must be treated as another piece of evidence which derives its force from the evidence of the expert's reliability.

That evidence may include such matters as the expert's qualifications, track record and apparent "dialectical superiority" in debates with another expert or a cross-examining lawyer.[33] It may also include some of the evidence relied upon by the expert, insofar as either the expert explains it to the court or the court hears independent evidence of the same facts. All the factors listed in the famous Daubert decision of the US Supreme Court[34] (testability, peer review and publication, whether there is a known error rate and "general acceptance) are indicators of reliability that a lay factfinder might reasonably use. So are the rather different factors set out in the UK Law Commission's report on expert evidence in criminal trials to determine of whether expert evidence is "sufficiently reliable to be admitted", which aim to encourage careful assessment by the judge of the inferential structure of the evidence: the data on which it is based and the soundness of the inferences drawn from it.[35] Whichever approach is adopted, a court can rarely hope, in an area where the science is at all contentious, to have conclusive evidence that a particular expert has got it right. There is always likely to be a gap between the confidence that genuinely well-informed and competent experts are entitled to have in their

[30] Déirdre Dwyer, The Judicial Assessment of Expert Evidence (Cambridge: Cambridge University Press, 2008) at pp. 313-5.

[31] Coopers Payen Ltd v Southampton Ferry Terminal Ltd [2003] EWCA Civ 1223 at para. 42.

[32] Robin Jacob, "Experts and Woolf: Have Things Got Better?" in Déirdre Dwyer (ed.) The Civil Procedure Rules Ten Years On (Oxford: Oxford University Press, 2009) pp. 293 et sqq. at p. 296.

[33] Alvin Goldman, "Experts: Which Ones Should You Trust?" 63 Philosophy and Phenomenological Research (2001) pp. 85 et sqq. at p. 95.

[34] Daubert v Merrell Dow Pharmaceuticals 509 US 579 (1993)

[35] Law Commission Expert Evidence in Criminal Proceedings in England and Wales (London: The Stationery Office, 2011) at para. 1.32.

own conclusions, and the confidence that a lay factfinder (including a judge) is entitled to have in those same conclusions.

The existence of a "confidence gap" between the expert and the court does not necessarily mean that whatever event the expert asserts is probable will have a lesser degree of probability from the court's standpoint. This may well be the case where the factfinder suspects a bias on the expert's part towards supporting a certain hypothesis, but not in other situations. For example, where a forensic scientist has to estimate the likelihood of a person other than the suspect wearing shoes with a particular sole pattern, it may be impossible to say whether the limitations in the available data would lead to an over- or underestimate of this probability (and thus in which direction they would bias a calculation of the likelihood ratio between certain shoe-prints being made by the suspect or another person).[36] Indeed, because of the difficulty of identifying the most appropriate reference class, there may be no single "correct" estimate of probability.[37] Similarly, in cases where the factfinder is not aware of specific flaws in the evidence but is simply not confident that there may be not be hidden flaws that only another expert could recognise, this does not necessarily indicate in which direction the expert may have erred.

The confidence that it is justifiable to have in a judgment of probability depends upon the weight (in J.M. Keynes' sense of the word)[38] or resiliency of the evidence on which it is based. The weight of the evidence reflects the amount of relevant evidence on which it is based – in this context, the evidence available to the factfinder, rather than the expert. The resiliency of the evidence is its susceptibility to revision in the light of further evidence.[39] These concepts are closely related but not identical;[40] the relation between them, however, need not detain us here. The important point is that because it has this dimension of weight or resiliency, the court's "belief probability" cannot be reduced to a number which is equivalent to a measure of

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[36] R v T (Footwear Mark Evidence) [2010] EWCA Crim 2439

[37] Ronald J. Allen and Michael S. Pardo, "The Problematic Value of Mathematical Models of Evidence" 36 Journal of Legal Studies (2007) pp. 107 et sqq.

[38] John Maynard Keynes, A Treatise on Probability (London: Macmillan, 1921) at p. 78; Stein, Foundations, supra note 5 at pp. 47-8.

[39] Ariel Porat and Alex Stein, Tort Liability under Uncertainty (Oxford: Oxford University Press, 2001), at p. 47.

[40] Although Stein, Foundations, supra note 5, treats them as interchangeable, David Hamer shows that when evidence applies to particular cases, increasing weight can sometimes decrease resiliency: "Probability, Anti-Resilience and the Weight of Expectation" 11 Law, Probability & Risk (2012) pp. 135 et sqq.

chance or epistemic probability. This is because the weight or resiliency of evidence is not directional: in itself, it does not increase or reduce the probability of the hypothesis the evidence serves to support (for example, exhaustively testing the fairness of a coin may simply make one more confident in one's initial assumption that the probability of heads is even).[41] I therefore agree with McIvor, but for a different reason, that the legal "balance of probabilities" standard cannot usefully be stated in numerical terms: it is not just "that ordinary human beings cannot differentiate between, for example, a 51% degree of belief and a 58% degree of belief",[42] but that even if they could, they would miss the distinction between greater and lesser degrees of confidence in the same degree of belief.

In the case of statistical evidence, it may appear that the confidence one may justifiably place in it is sufficiently quantified by the statement of a "confidence interval".[43] As Barnes points out, however, confidence intervals take account of what he calls the "sampling error probability" but not of other sources of error such as methodological flaws of which the expert may be unaware.[44] Thus they cannot bridge the gap between "fact probability" and "belief probability" in Barnes' sense of the terms. As the judgment in XYZ v Schering vividly illustrates, epidemiologists' statements of confidence intervals do not necessarily inspire confidence on the part of judges![45]

What XYZ also illustrates is that in some cases involving epidemiological evidence, the court has the benefit of a very thorough discussion of the opposing scientific views.[46] If this debate is conducted in such a way that the judge is able grasp the inferential structure of the opposing arguments and appreciate their strong and weak points, [47] the court may reasonably take itself to be entitled to a relatively high level of confidence that those expert claims that survive the adversarial process are sound. Whether such a happy situation obtains in the case of complex epidemiological disputes is debatable.[48]

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[41] Jonathan E. Adler, *Belief's* Own Ethics (Cambridge, MA: MIT Press, 2002) at pp. 250-2.

[42] McIvor, "Debunking", supra note 12, at p. 581.

[43] Neil B. Cohen, "Confidence in Probability: Burdens of Persuasion in a World of Imperfect Knowledge" 60 New York University Law Review (1985) pp. 385 et sqq.

[44] Barnes, "Probabilities", supra note 24 at p. 195.

[45] XYZ v Schering Health Care [2002] EWHC 1420 (QB) at paras, 37-40.

[46] See e.g. XYZ v Schering Health Care [2002] EWHC 1420 (QB)

[47] Dwyer, Assessment, supra note 31 at pp. 98-101, 104-7.

[48]For a critical view of XYZ see Klim McPherson, "One Expert's Experience" in Louis Blom-Cooper (ed.) Experts in the Civil Courts (Oxford: Oxford University Press, 2006) pp. 159 et sqq.; but contrast Richard

When a court has limited confidence in expert evidence it may resolve any doubt about the strength of the evidence against the party that bears the burden of proof. This would have been the main effect of the Law Commission's recommendations (rejected by the government on cost grounds) about expert evidence in criminal trials, which envisaged that "the strength of the expert's opinion evidence, together with the burden and standard of proof to be applied …would determine the foundation of knowledge and research data needed to demonstrate that that opinion evidence is sufficiently reliable to be admitted."[49] What this would in effect have meant was that few kinds of evidence would be absolutely excluded but the expert would be limited to expressing a degree of support for the relevant hypothesis which the judge considered to be backed up by sufficiently weighty reasons.[50] Where limiting the evidence in this way rendered the prosecution incapable of discharging the burden of proof, the case would effectively be over. The concern with exclusion both here and in Daubert,[51] reflects the division of roles between the judge and jury, and does not arise in the same way in tort trials heard by a judge alone.

One of the themes of Sienkiewicz v Greif is that epidemiological evidence should be approached with caution and not "carry a false air of authority".[52] Although some of criticism directed specifically at epidemiology appears misconceived,[53] the general point about the need to evaluate any form of expert evidence critically, and not simply to defer to the expert's quantification of probabilities, is well taken. But while Lords Phillips and Dyson were prepared to accept that in principle, sufficiently cogent epidemiological evidence could suffice to prove causation,[54] the other four justices who (unlike Lord Brown) joined the debate about epidemiology thought that there was something inherently objectionable about proving causation by "naked statistical evidence". Lord Rodger, Baroness Hale and Lord Kerr all

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Wakeford, "Epidemiology and Litigation: The Sellafield Child Leukaemia Cases" 161 Journal of the Royal Statistical Society. Series A (Statistics in Society) (1998), pp. 313 et sqq., discussing Reay and Hope v British Nuclear Fuels plc [1994] Env LR 320.

[49] Law Commission, supra note 36, para. 3.113.

[50] Tony Ward, "Expert Evidence and the Law Commission: Implementation without Legislation?" Criminal Law Review (2013) pp. 561 et sqq.

[51] Supra, note 35.

[52] Supra, note 10, at para. 206 (Lord Kerr), 217 (Lord Dyson).

[53] McIvor, supra note 6

[54] Sienkiewicz, supra note 10, at paras. 91, 222.

insisted that there must be additional evidence to connect the alleged cause with the particular facts of the case.[55] Lord Mance declined to lay down a general rule but thought that proof by purely epidemiological evidence would be appropriate only "in the rarest of cases".[56] The final part of this article seeks to understand, and ultimately to refute, those arguments.

IV. **Sienkiewicz and the Civil Standard of Proof**

The relationship between the strength and weight of evidence has been much discussed in legal scholarship since L.J. Cohen's The Probable and the Provable was published in 1977.[57] Discussion has not usually centred on the general epistemological problems of expert testimony, but rather on the view that the majority of the Supreme Court in Sienkiewicz appears to support, that statistical evidence unsupported by case-specific or "individualised" evidence, can never or only very exceptionally have sufficient weight to satisfy the civil standard of proof.

Such arguments often appeal to "proof paradoxes" such as the one mentioned in Sienkiewicz about a claimant being run down by an unidentified taxi in a town where the majority of taxis belong to a single firm.[58] The common feature of all the alleged paradoxes is that the defendant is shown to be more likely than not to be liable on the basis of evidence that is extraordinarily slender compared to the kind of evidence that one would normally expect to find in such a case (for example, the taxi cab hypothetical assumes that the defendant company has no record of where its cabs were at the time of the accident). It is not immediately obvious how the leap is made from the intuition that in these unlikely scenarios the statistical evidence is of so little weight that a verdict based on it would be unjust, to the conclusion that all statistical evidence is similarly deficient.[59] In particular, it is far from obvious why the same conclusion should be reached in cases such as those of "toxic tort" causation, where in the nature of the case is such that the available evidence of causation is likely to be largely

[55] Ibid. at paras. 162-3, 170, 205.

[56] Ibid. at para. 192.

[57] L. Jonathan Cohen, The Probable and the Provable (Oxford: Oxford University Press, 1977).

[58] Sienkiewicz, supra note 10 para. 171 (a variation on the "blue bus" problem introduced by Laurence H. Tribe, "Trial by Mathematics" 84 Harvard Law Review (1971) pp. 1131 et sqq. at pp. 1140-1).

[59] Dale A. Nance, "Allocating the Risk of Error: Its Role in the Theory of Evidence Law" 13 Legal Theory (2007) pp. 129 et sqq at pp. 140-3.

statistical (although it is a misleading simplification to think of epidemiological evidence as purely statistical).[60]

The best argument for the view that statistical evidence alone cannot prove liability does not rely on the evidence's inherent lack of weight but rather on the nature of the belief that a factfinder has to form in order to pronounce a verdict. As Cohen puts it: "the standard of proof in civil cases is to be interpreted in terms leading one to expect that, after all the evidence has been heard, a balance of probability in favour of a certain conclusion will produce belief in the truth of that conclusion among reasonable men."[61] Similarly, Richard Wright has plausibly argued that the dicta in Sienkiewicz support his own view that "naked" statistical evidence cannot establish liability because the civil standard of proof requires "the formation of a minimal belief regarding the truth of the fact(s) at issue, rather than a mere 50+ per cent statistical probability".[62]

This interpretation makes sense of the passages in the judgments of Lord Rodger and Baroness Hale which, at first sight, appear to deny "Principal Principle" connecting chances and epistemic probabilities. When Lord Rodger says that the cause of a claimant's disease "remains unknown" where the evidence is purely statistical,[63] and when Baroness Hale says that "the existence of a statistically significant association between factor X and disease Y does not prove that in the individual case it is more likely than not that factor X caused disease Y"[64] the contrast they are drawing, on this interpretation, is not between chances and epistemic probabilities, but rather between epistemic probabilities and the kind of belief that could be considered to amount to "knowledge" or "proof". Similarly when Lord Dyson remarks that "Whether an inference of belief probability should be drawn in any given case is not a matter of logic,"[65] he seems to be using "belief probability" to mean an unquantifiable degree of conviction on the judge's part, as opposed to a calculable epistemic probability or "degree of belief". Wright calls such a conviction "minimal belief" – an attitude that takes the fact in issue as true, though not necessarily with a high level of confidence. As Wright points out, a

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[60] McIvor, supra note 12

[61] Cohen, The Probable, supra note 53 at p. 81.

[62] Richard W. Wright, "Proving Causation: Probability versus Belief" In Richard Goldberg (ed.) Perspectives on Causation (Oxford: Hart, 2011), pp. 195 et sqq., at pp. 199-200

[63] Sienkiewicz, supra note 10 at para. 156

[64] Ibid., para. 170

[65] Sienkiewicz, para. 222.

"minimal belief" is different from a willingness to accept a hypothetical bet on the proposition in question.[66]

This argument accords with the "belief account of factfinding" developed by H. L. Ho.[67] Ho argues that a positive finding of fact – a finding in favour of the party that bears the burden of proof – amounts to an assertion of that fact, and such an assertion is justified only if it is reasonable to believe it categorically on the basis of the evidence. "One believes categorically that p when one judges that p is, in fact, true…. Only categorical belief that p justifies the outright assertion that p."[68] A "partial belief" or epistemic probability will not do.

The trouble with Ho's account, as with the similar accounts by Cohen and Wright, is that it does not reflect the nature of the civil standard of proof in English law, nor does it afford a strong argument to change that standard, at least in relation to issues such as causation in tort. In relation to criminal trials, Ho's "belief account of factfinding" is persuasive; but it is persuasive, in part, because of a particular feature of criminal law, the moral censure implicit in a conviction. One cannot justifiably censure someone without a firm belief in their culpability, and the requirement that the jury should be "sure" of everything the prosecution has to prove reflects this moral objective of the trial.[69] Some issues in civil trials also imply grave moral blame, and in these respects there may a case for applying "a sort of presumption of innocence" to civil defendants.[70] To base a decision whether someone has acted wrongfully on "naked statistical evidence" is open to the objection that it disrespects the autonomy of individuals to treat them as culpable merely because of their membership of a certain class.[71] But such considerations have little bearing on questions of causation involving corporations whose negligence has been established on non-statistical grounds.[72] In this respect there is no

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[66] Richard H. Wright, "Causation, Responsibility, Risk, Probability, Naked Statistics, and Proof: Pruning the Bramble Bush by Clarifying the Concepts" 76 Iowa Law Review (1988) pp. 1001 et sqq. at pp. 1063-4.

[67] Ho Hock Lai, A Philosophy of Evidence Law (Oxford: Oxford University Press, 2008) at pp. 92-9.

[68] Ibid. at p. 127.

[69] Antony Duff, Lindsay Farmer, Sandra Marshall and Victor Tadros, The Trial on Trial, vol. 3: Towards a Normative Theory of the Criminal Trial (Oxford: Hart, 2007) at p. 71; Adler, Ethics, supra note # at pp. 216-7; Ho, Philosophy, supra note 74 at pp. 194, 197.

[70] Ho, Philosophy, supra note 74 at p. 226.

[71] David T. Wasserman, "The Morality of Statistical Proof and the Risk of Mistaken Liability" 13 Cardozo Law Review (1991) pp. 935 et sqq.

[72] Amit Pundik, "Statistical Evidence and Individual Litigants: A Reconsideration of Wasserman's

reason to tip the scales of justice in favour of defendants, and a standard of proof which treats whatever is more likely than not to have occurred as if it had actually had occurred distributes the risk of error equally between the parties.[73]

The vast majority of English civil cases are decided by judges who make detailed, reasoned, findings of fact and can make it clear whether they are asserting that an event occurred or merely that it is more likely than not. The latter is all a judge need categorically believe to give judgment on the balance of probabilities. The series of cases on the civil standard decided since Ho's book was published[74] is consistent with this view and at odds with Ho's position which favours a variable standard of proof in civil trials. The clearest statement in these cases on what the "balance of probabilities" means was made by Lord Hoffman in Re B.[75] This was an appeal in a child protection case where the trial judge found the evidence both for and against an allegation of sexual abuse to be utterly unreliable. The judge made it clear that he did not believe either that the child had been abused or that she had not. As Lord Hoffman said, however:

> In our legal system, if a judge finds it more likely than not that something did take place, then it is treated as having taken place. If he finds it more likely than not that it did not take place, then it is treated as not having taken place. He is not allowed to sit on the fence. He has to find for one side or the other. Sometimes the burden of proof will come to his rescue: the party with the burden of showing that something took place will not have satisfied him that it did. But generally speaking a judge is able to make up his mind where the truth lies without needing to rely upon the burden of proof.[76]

When an event is found to be "more likely than not" and is therefore "treated as having taken place", the court accepts that it took place for the purpose of determining liability. As Raz puts it:

Argument from Autonomy" 12 International Journal of Evidence and Proof (2008) pp. 203 et sqq.

[73] Mike Redmayne, "Standards of Proof in Civil Litigation" 62 Modern Law Review (1999) pp. 62 et sqq.

[74] See supra, note 2.

[75] Re B, supra note 2

[76] Ibid., at para. 32.

> accepting a proposition is conducting oneself in accord with, and because of, the belief that there is sufficient reason to act on the assumption that the proposition is true: acceptance of the proposition that P entails belief, but not belief that P. Rather it entails belief that it is justified to act as if P.[77]

When Lord Hoffman speaks of the judge "making up is mind where the truth lies", he must mean that even a judge like the one in Re B who cannot say where the truth about an alleged event lies can usually discern the truth about whether it is more likely than not given the available evidence. Forming a categorical belief about that justifies the judge in treating the event as having taken place, i.e. accepting it and acting on the basis of it, except in cases such as the taxi cabs hypothetical where acting on the more probable proposition would be manifestly unjust. Pace Raz, however, such acceptance-based verdicts are appropriate only in civil cases – and perhaps not even in all of those.

If this account of the civil standard of proof is right, then we must be careful not to be misled by the distinction Lord Rodger drew in Sienkiewicz between '[p]roof of a fact and proof of a probability'.[78] Clearly there is no question of holding defendants "liable for all the damage which a court was satisfied, on the balance of probability, they had probably caused".[79] The balance of probabilities cannot be applied to itself. The standard is that the claimant must satisfy the court that causation is more likely than not. That is, the judge must believe causation is more likely than not, with sufficient confidence to justify a verdict. The degree of likelihood can be quantified, but the degree of confidence cannot. On Raz's account of acceptance, the judge must fully believe that it is justifiable to act on the basis of the partial belief that causation occurred.

We can agree with Wright that such a belief it will typically be formed on the basis an unquantifiable degree of "coherent fit" between several pieces of evidence and an explanatory story.[80] This is so, however, even in cases of supposedly "naked" epidemiological evidence, because there must be some evidence connecting the epidemiological evidence to the facts of the case to establish that it is relevant at all, and because any epidemiological claim will rely

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[77] Joseph Raz, From Normativity to Responsibility (Oxford: Oxford University Press, 2011) at p. 37 (adopting a suggestion by Ulrike Heuer).

[78] Supra, note 10, sub-heading at para. 154.

[79] Ibid., para. 158, emphasis added.

[80] Wright, "Proving Causation", supra note 51 at p. 209.

on some general causal inference that purports to explain the higher risk of harm in exposed populations.[81] If the claimant can prove that she was tortiously exposed to a substance which the epidemiological evidence (both statistical and biological) shows to be harmful, and suffered the kind of harm which the evidence shows the substance to cause, she presents a coherent story which may be sufficiently cogent to satisfy the judge that the exposure more likely caused the harm than not.

[81] Broadbent, "Epidemiological Evidence" supra note 7.