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Expert Signs and Legal Burdens

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Abstract
Expert signs and expert evidence generate a justification problem in legal factfinding: factfinders cannot form a justified belief about the relevant matter, nor justify the acceptance of an expert testimony, insofar as they do not understand it. The different profiles of factfinders in different legal systems (with jury trial or not) do not make a substantial difference for the point addressed, namely the epistemic or doxastic impasse generated by the inability to understand expert signs, for this occurs everywhere. However, legal systems have a way out of the impasse: burdens of proof. Burden rules govern the outcome of a case. If a burden is not discharged, decision must be against the burdened party. After discussing various aspects of the "Daubert trilogy" and performing a semiotic analysis of one case in particular (*Kumho*), the paper explores the impact that legal burdens have on expert evidence issues.

Keywords Burdens of proof · Daubert trilogy · Evidence · Expert testimony · Factfinding · Legal argumentation

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1 Introduction

Have you ever discussed a "reanalysis" of epidemiological studies to the purpose of establishing whether a given substance is a human teratogen? Do you know what polychlorinated biphenyls are? Do you know what experts mean by "beads" when talking about a tire? What about a "bead seat" in the same context?

Actually, those are examples of expert questions for legal factfinders.[1] They are taken from well-known cases that will be considered below. Those cases are mostly known for legal reasons, as it will be clear, and the examples have nothing special. Examples of this sort are legion, for contemporary legal practice shows that a remarkable and increasing amount of legal controversies depend on the answers to expert questions. The subjects vary a lot, from chemistry and botany to psychiatry and economics, from the causes of pollution to the causes of schizophrenia, from medical malpractice to antitrust cases, including technical issues and supposedly technical disciplines such as tire failure analysis.

All of that comes with a concern that is now a refrain: How can legal factfinders adjudicate disputes whose content turns out to be expert, if they lack the relevant expertise? Judges are mainly trained in law; jurors are supposed to rely on standard knowledge and common sense. What is the point of providing expert evidence if the factfinders cannot appreciate its details or do not even understand it? There is a vast and growing literature on this subject and the problem highlighted.[2] But, as far as I know, there is little analysis of the *semiotic aspects* of expert testimony and expert evidence, and little consideration of the impact that *legal burdens* have on expert evidence issues.

Let me start from some semiotic aspects. Expert signs are often unintelligible to non-experts. Take "polychlorinated biphenyls", or other special signs used in chemistry. Non-experts do not grasp their meaning. They do not know what those signs refer to. They hardly know what to do with them. When expert witnesses provide them, they sound like Mandarin to someone who is at ease with *Begriffsjurisprudenz* (the judge) or with football and pizza (the juror). This is not entirely a joke. Expert testimony provides indeed a peculiar kind of evidence, since (i) it employs expert signs, (ii) the non-expert recipients can hardly understand it, and (iii) it is not just transmission of information, but also production of information.[3] Consider, as a rather familiar example, blood or tissue analysis. Blood analysis, simply put, is the laboratory examination of a sample of blood used to obtain information about its physical and chemical properties. The naked eye cannot see these properties. Lay

[1] As an essential glossary for non-expert readers, remember that in legal parlance "factfinders" refers to judges and jurors; "expert witness" to the witness who has special knowledge or experience in a particular field; "lay witness" to the witness who is not testifying as an expert one; "testimony" to the act of testifying about something.

[2] See, among others, [14], [8], [26], [21], [17], [2], [39], [9].

[3] As an additional point, expert testimony is usually on secondary facts, and the expert is supposed to *infer* from them some *probanda* or even the primary facts of the case, whereas in general lay witnesses must only report what they *perceived* (see [42]). The primary facts are the legally relevant ones, the *ultimate probanda*.

people cannot perform the relevant tests. Nor do they know the vocabulary that is used to present and explain the results, or they know it only in part. So, it is no surprise that in complex cases things can become highly controversial in those respects.

Those features of expert signs and testimony generate a justification problem in legal factfinding: factfinders cannot form a justified belief about the matter, nor can they justify the acceptance of a given expert testimony, insofar as they do not understand it or cannot appreciate some important aspects of it.[4] The different profiles of the factfinders in different legal systems (with jury trial or not) do not make a substantial difference here. Both judges and jurors, when facing some expert evidence that they do not understand, end up in a sort of epistemic or doxastic impasse: they cannot form a justified belief, nor can they say whether they have acquired the relevant knowledge.

However, legal systems have a way out of the impasse: burdens of proof, or legal burdens more generally speaking. Here is a sketch of the argument that the present work will develop in greater detail. The rules on burdens govern the outcome of a legal case. If a burden is not discharged, the decision must be against the burdened party. So, when factfinders face (competing) expert testimonies and find themselves in a doubtful situation, this means that the burden has not been discharged. Then factfinders must decide against the burdened party (both in criminal and civil cases). Burdens generate an asymmetry that results in adverse decisions when burdens are not discharged. To put that differently, if the expert testimony supporting the case of the burdened party does not prove to be the best explanation of the available evidence, then the burdened party must lose.

Educating factfinders and appointing expert factfinders are possible strategies to domesticate the problem. They are likely to reduce the percentage of doubtful cases. But some doubtful cases would most certainly occur in spite of that, and in such cases the proper outcome would remain the same: namely, deciding against the burdened party when the burden is not discharged. This is one of the ways in which legal normativity impacts factual determinations, for the law cannot postpone indefinitely the resolution of a dispute. Scientific determinations occur in a long-run perspective; legal determinations do not have this privilege. In this respect, legal norms structure the factfinding process. On the other hand, expert signs usually transcend the specific features of legal systems: signs carrying information about natural and causal processes do not depend on legal norms. This means that the semiotic reach of expert testimonies is "global", not local, even though understanding them is often difficult.

The work proceeds as follows. Section 2 presents the scheme of the argument from expert opinion and some legal cases where expert evidence was at stake (the "Daubert trilogy"). A legal analysis is performed with respect to that. Section 3, taking cues from Peirce's semiotics and Millikan's picture of natural and intentional signs, explores some semiotic dimensions of expert evidence. A semiotic analysis of a specific case (*Kumho*, belonging to the Daubert trilogy) is carried out, and some

[4] Cf. [49] (arguing against a justified-true-belief account, due to the defeasibility of scientific knowledge, and praising an acceptance account).

advice for expert witnesses is tentatively drawn from that. Next, Section 4 explores the relations between expert testimony and burdens of proof. This goes deeper into the legal logic that governs the use of expert signs. Section 5 concludes by claiming that decision according to burden rules is legally appropriate when factfinders make their best effort to understand the (expert) evidence and the case at hand remains doubtful notwithstanding this effort.

In a nutshell, my main claims are that a better understanding of the semiotic aspects of expert testimonies will help parties, witnesses and factfinders handle expert evidence, and that, when cases remain doubtful, burdens of proof provide the appropriate legal answer.

2 Expert Signs: A Legal Analysis

In a recent book, Walton, Macagno and Sartor [48, p. 212] present the following as the scheme of the argument from expert opinion:

> Minor premise 1: Source *E* is an expert in subject domain *S* containing proposition *A*.
> Minor premise 2: *E* asserts that proposition *A* (in domain *S*) is true (false).
> Major premise: If source *E* is an expert in a subject domain *S* containing proposition *A*, and *E* asserts that proposition *A* is true (false), then *A* may plausibly be taken to be true (false).
> Conclusion: *A* may plausibly be taken to be true (false).

This is a rational reconstruction of the actual use of the argument, supplemented with an understanding of its merits and limits: Walton, Macagno and Sartor stress that conclusions provided in this way are plausible, not necessarily true or necessarily false. Differently put, conclusions of this sort are defeasible in light of additional information or of additional questioning and critical reflection.[5] Asking critical questions has tremendous importance, both to advance knowledge and to resolve practical problems. For example: Is *E* a genuine expert? What are the credentials of *E*? Is *E*'s methodology reliable? Was the methodology reliably applied to the case? And so forth.

In the debate over the role of expert evidence in legal proceedings, an international turning point was the so-called Daubert trilogy, namely the three decisions of the U.S. Supreme Court, between 1993 and 1999, on the use of expert evidence in the American federal system. The echoes of the trilogy have been significant also elsewhere, as in Latin America and Europe.[6] The three were civil cases in which the evidence was proffered to show what had caused a given harm (in two cases a

[5] "Since experts are generally not omniscient, and since in law it would be a great error to take what an expert says uncritically, this inference must be viewed as being defeasible." [48, p. 212] In Peircean terms, it is a matter of *abduction* (see [31, p. 231]—from *Pragmatism as the Logic of Abduction*, 1903—and [41]).

[6] See e.g. [46], [12], [10], [45].

pathology, in the third an accident); but their reach extends to criminal cases. Those decisions have sparked indeed a storm of comments, opinions, articles, books and treatises on what counts as "scientific evidence" and "expert evidence" in the legal field; on the criteria by which to distinguish "genuine science" from "junk science"; and on the rules concerning the admission and use of such evidence in order to decide a legal dispute. Expert readers know the details of the story; let us summarize it for the non-expert ones.

In *Daubert*, the decision that started the contemporary debate,[7] the Court said that it was called upon to determine the standard for admitting expert scientific testimony in a federal trial. The petitioners alleged that the birth defects of their son, Jason Daubert, had been caused by the mother's prenatal ingestion of Bendectin, an anti-nausea drug marketed by Merrell Dow Pharmaceuticals. This was the causal claim upon which damages would have been asked to Merrell Dow. But, of course, the claim had to be proven. The petitioners proffered the testimony of eight well-credentialed experts who based their conclusion, namely that Bendectin can cause birth defects, on animal studies, chemical structure analyses, and the unpublished "reanalysis" of previously published human statistical studies. The equally well-credentialed expert of Merrell Dow concluded, upon reviewing the published scientific literature on the subject, that maternal use of Bendectin had not been shown to be a risk factor for human birth defects. The District Court and the Court of Appeals excluded the petitioners' proffered evidence assuming it did not meet the "general acceptance" standard set by *Frye* (a 1923 decision that counted as precedent).[8] The Supreme Court thought, instead, that the controlling standard was set by the Federal Rules Evidence (FRE, enacted in 1975). Such a rigid standard as *Frye*, said the Court, would be at odds with the Rules' "liberal thrust" and their general approach of relaxing the traditional barriers to the admission of (expert) evidence. Still, according to the Court, Rule 702 placed limits on the admission of expert evidence by assigning to the trial judge the task of ensuring that an expert testimony both rests on a *reliable* foundation and is *relevant* to the task at hand. The "reliability" requirement was not explicit in the text of the Rule, though; the Court took it as implicit in the idea of "scientific knowledge" to which the Rule referred.[9]

The Court listed some "factors" for telling genuine science from junk, asking the judges to make this assessment when admitting the evidence. Once admitted, in jury trials the evidence is taken for the benefit of the jurors who, as is well known, decide on the merits without giving reasons for their decision. (Remember, however, that they receive "instructions" from the judges on the relevant rules and standards of

[7] Daubert v. Merrell Dow Pharmaceuticals, Inc., 509 U.S. 579 (1993).

[8] Frye v. United States, 54 App. D.C. 46, 293 F. 1013 (1923). This was a criminal case, where counsel for defendant offered an expert witness to testify to the result of a deception test made upon defendant; the testimony was excluded because, to be admissible, expert testimony "must be sufficiently established to have gained general acceptance in the particular field in which it belongs" and "the systolic blood pressure deception test has not yet gained such standing and scientific recognition".

[9] "The adjective 'scientific' implies a grounding in the methods and procedures of science. Similarly, the word 'knowledge' connotes more than subjective belief or unsupported speculation." (part II.B of the decision)

proof.) The fact that reasons are not given explains why, in a jury trial system, a significant "filter" is needed at the time of admission. The point is preventing jurors from hearing fake expert testimony and "junk science" in particular, that is, pseudoscience that might be presented in such a way as to be persuasive on non-experts as jurors.[10] Thus, under *Daubert*, judges have to carry out this "filtering" operation by excluding what does not satisfy the reliability standard of "scientific knowledge" and admitting what meets it (provided the evidence is relevant to what must be proven, of course).

The well-known "factors" indicated by *Daubert*—part II.C of the decision—were the following:

(1) Whether a theory or technique can be (and has been) *tested*;
(2) Whether it has been subjected to *peer review* and publication process;
(3) Whether, in respect to a particular technique, there is a known or potential *error rate* (e.g. of spectrographic voice identification technique), considering also the existence and maintenance of standards controlling the technique's operation;
(4) Whether the theory or technique enjoys *general acceptance* in the relevant field.[11]

The Court listed them as pertinent considerations on the issue of methodological or scientific validity and reliability; they were not meant as a "definitive checklist or test". Nor did the Court say that they must be met jointly, and that each of them constitutes a necessary condition of reliability. The inquiry envisioned by Rule 702, said the Court, is a "flexible one". Still, notwithstanding this sort of flexibility, the Court assigned to federal judges the "gatekeeping" role of excluding unreliable evidence. In fact, the application trend that followed *Daubert* in civil cases has been more restrictive than what the Court seemed to imagine, since judges have been taking their gatekeeping role much seriously and have been applying those indications quite restrictively. This was accompanied by the understandable concern generated by the idea that non-experts (judges) make decisions on expert issues.

As to the role of critical questions, notice that in *Daubert* the credentials of the experts were not a matter of dispute. All the experts involved were considered to be well-credentialed. The problem was in the methodology of the petitioners' experts. Proposition *A*, in the scheme provided by Walton, Macagno and Sartor, would be like this: "Maternal prenatal ingestion of *Bendectin* can cause birth defects." The petitioners' experts asserted that *A* is true and was supported by evidence. The expert of Merrell Dow asserted instead that nothing in the published literature supported *A*. The Court stated what is required for admission purposes as a matter of

[10] On the more general epistemological problem of sifting knowledge from garbage, see [15].

[11] Specifically, it can be observed that the fourth factor echoes the *Frye* standard; but in this context the "general acceptance" consideration is just one of the factors that help establish reliability. It is not a *sine qua non*.

methodology, and in the proceedings after *Daubert* the proffered evidence was not admitted either.[12]

In *Joiner*, the second decision of the trilogy,[13] the causal claim was that the small-cell lung cancer of Robert Joiner had been "promoted" by his workplace exposure to polychlorinated biphenyls (PCBs) and derivative furans and dioxins that were manufactured by, or present in materials manufactured by, General Electric. Joiner had been al electrician for several years, since 1973. PCBs had been banned by Congress in 1978, with limited exceptions, due to their being considered hazardous to human health. Joiner's experts claimed, as a general matter, that exposure to those chemicals promotes cancer, and that, in the instant case, Joiner's exposure to those chemicals was likely responsible for his cancer. Again, the proffered evidence was challenged as to admissibility and the final decision was against Joiner.

It is apparent that non-experts have no idea whether PCBs, furans and dioxins promote cancer and to what extent. In addition, it was reported that Joiner had been a smoker for approximately eight years and there was a history of lung cancer in his family. It was also unclear whether he had been really exposed to furans and dioxins. The crucial point concerned PCBs. And here were some weaknesses of the argument in his favor (part III of the decision). The animal studies proffered by Joiner's experts were "so dissimilar" from the facts of the case, in the opinion of the Supreme Court, as to justify an inadmissibility ruling. They were studies involving infant mice in which alveologenic adenomas (a form of benign tumor) developed after massive doses of PCBs were injected into their bodies (in the peritoneum or stomach), while Joiner was an adult human who had developed small-cell lung cancer after being exposed to these substances on a much smaller scale. Analytically, five differences could be identified between Joiner's case and the animal studies considered:

(1) The studies were on mice and Joiner was a human being;
(2) The studies were on infant mice and Joiner was an adult;
(3) The mice were injected doses of PCBs, while Joiner was exposed to them;
(4) The injected doses were massive and highly concentrated, whereas Joiner was exposed on a much smaller scale;
(5) The mice had developed alveologenic adenomas, while Joiner had developed a lung cancer.

Some of these (the first and second in particular) are points that strike the non-expert hearer too; some others (especially the last) tell much less to the non-expert.

Furthermore, the expert evidence proffered by Joiner included some epidemiological studies which were not judged admissible either, for the following reasons:

[12] For more details on this, see [17, p. 104ff, 182ff].

[13] General Electric Co. v. Joiner, 522 U.S. 136 (1997). A significant aspect of the case was the discussion on the standard of review of district court evidentiary rulings by appellate courts. According to *Joiner*, the standard of review remains the traditional "abuse of discretion" one. This is not essential to our present purposes.

two of these studies (one Italian and one American) were reluctant to admit, about a sample of workers examined, a connection between PCBs and carcinoma, despite having detected a higher than expected incidence rate of the disease; a third study (Norwegian) concerned exposure to a certain mineral oil that was not relevant in Joiner's case; a fourth study (Japanese) concerned exposure to other potentially carcinogenic substances in addition to PCBs, including a toxic rice oil that workers had apparently ingested. Therefore, here too several differences appeared; these in particular:

(A) The third study was on exposure to a certain mineral oil, while Joiner had been exposed to PCBs;
(B) The fourth study concerned exposure to other potentially carcinogenic substances in addition to PCBs, while Joiner was found to have been exposed to PCBs and not to these other substances.

These differences seemed to justify the claim of a disanalogy between the case of Joiner and the studies invoked. Exclusion of the expert evidence followed, as the Supreme Court considered correct given its own precedent, namely *Daubert*.

On the other hand, one might wonder—as Susan Haack did—whether the set of such studies, animal and epidemiological, were not actually sufficient to support Joiner's claim. In a holistic assessment of the items of evidence, where they combine like the pieces of a mosaic or crossword puzzle, it may be the case that no one individually taken meets a certain decision standard but that the whole does. An atomistic assessment of epistemological reliability and legal admissibility led to an outcome that could have been different from a holistic perspective, as suggested by the dissent of Justice Stevens, according to Haack [17, pp. 215–216].[14]

By the way, there is a puzzling passage in the argument of the *Joiner*'s Court (again, in part III of the decision). *Daubert* insisted that the screening must be solely on principles and methodology, not on the conclusions that they generate. *Joiner* has it that conclusions must be considered too, because "conclusions and methodology are not entirely distinct from one another."[15] What makes sense of this claim is the fact that, apparently, Joiner's experts had been following the same methodology of the General Electric's experts; this would have been embarrassing for an exclusion on the basis of methodology alone. As a result, the *Joiner*'s Court partly departed from *Daubert* in this respect.

So, in *Joiner* the critical questions were neither on the credentials nor on the methodology of the experts. They were on the results, on the conclusions of the proffered studies. For those who worry about non-expert gatekeeping, this is a

[14] More specifically, a Daubert ruling can be qualified as atomist in two senses: (1) as a check on any individual factor of the list; (2) as a check on any individual piece of expert evidence. Haack discusses the second, basically; but this does not exclude that judges decide holistically in the first sense, considering the factors together (remember that the list was meant in a liberal spirit).

[15] For sure they are not "entirely" distinct. The difficult point is to state in what respects their relation matters here. A reasonable claim, added by the Court, is that judges "may conclude that there is simply too great an analytical gap between the data and the opinion proffered." Cf. [18, p. 18].

source of greater concern if judges end up being responsible both for methodological assessment and assessment of the merits.

Kumho, the last decision of the trilogy, was again a tort case.[16] The following is a summary of the facts, drawn from the decision. When a tire on the vehicle driven by Patrick Carmichael blew out and the vehicle overturned, one passenger died and the others were injured. The survivors and the decedent's representative brought suit against the tire's maker and its distributor (collectively Kumho Tire), claiming that the tire was defective. They rested their case in significant part upon the depositions of a tire failure analyst, Dennis Carlson, Jr., who intended to testify that, in his expert opinion, a defect in the tire's manufacture or design caused the blowout. On the other hand, Carlson conceded that that tire had traveled far enough so that some of the tread had been worn bald; the tire should have been taken out of service; it had been repaired (inadequately) for punctures; and it bore some of the very marks that he said indicated, not a defect, but abuse.

Carlson's expert testimony was not admitted under *Daubert*, since there was no testing in support of it, nor was an error rate specified, nor had Carlson's theory been submitted to peer review, nor had it gained general acceptance in the field. But against Kumho Tire the appellate decision argued that the Daubert factors applied to *scientific* testimony, not to other forms of it such as testimony based on technical or professional expertise (e.g. of engineers). Carlson claimed he was able to detect defective tires by "visual and tactile inspection" (more on this below).

The Supreme Court admitted that some expert testimony is not "scientific" in the strict sense. An expert opinion based on skill or experience can fall short of the criteria that define "science" in the strict sense. However, claimed the Court, *Daubert* applied not only to scientific but to any expert testimony. (One of the reasons for this conclusion was avoiding the trouble of drawing a clear line dividing science and technical or other specialized knowledge.) Any expert testimony must not only be relevant but also *reliable*. The four Daubert factors help determine reliability (as illustrations of it, stressed the Court), and Carlson's opinion failed in this respect. So, the final decision was in favor of Kumho Tire: the opinion of the tire failure analyst was not admissible under the gatekeeping standards set by *Daubert*.

The Court insisted on the fact that the inquiry envisaged by Rule 702 (as interpreted in *Daubert*) is flexible:

> Indeed, those factors do not all necessarily apply even in every instance in which the reliability of scientific testimony is challenged. It might not be surprising in a particular case, for example, that a claim made by a scientific witness has never been the subject of peer review, for the particular application at issue may never previously have interested any scientist. Nor, on the other hand, does the presence of *Daubert*'s general acceptance factor help show that an expert's testimony is reliable where the discipline itself lacks reliability, as, for example, do theories grounded in any so-called generally accepted principles of astrology or necromancy. (part II.B of the decision)

[16] Kumho Tire Co. v. Carmichael, 526 U.S. 137 (1999).

At the same time, some of those factors can help evaluate the reliability even of experience-based testimony:

> In certain cases, it will be appropriate for the trial judge to ask, for example, how often an engineering expert's experience-based methodology has produced erroneous results, or whether such a method is generally accepted in the relevant engineering community. Likewise, it will at times be useful to ask even of a witness whose expertise is based purely on experience, say, a perfume tester able to distinguish among 140 odors at a sniff, whether his preparation is of a kind that others in the field would recognize as acceptable. (ibid.)

As to critical questions, Carlson's credentials were not disputed; nor was disputed his methodology in the abstract (though there had been doubts about it). The major flaw was the dubious application of his methodology to the actual case.[17]

Readers will remember that the reliability requirement was not explicit in Rule 702. After *Kumho* the U.S. Congress decided to amend the text of the rule in order to make it explicit. Now expert testimony must be "the product of reliable principles and methods" (FRE 702(c)), and it may be admitted if "the expert has reliably applied the principles and methods to the facts of the case" (FRE 702(d)).[18]

3 Expert Signs: A Semiotic Analysis

After the legal analysis of the preceding section, a semiotic analysis is in order. This will provide a better understanding of the issue and will likely help parties, witnesses and factfinders handle expert evidence. Let us look at *Kumho* in greater detail. A part of the decision reports several technicalities about tires. Here are some features of tire technology:

> A steel-belted radial tire like the Carmichaels' is made up of a "carcass" containing many layers of flexible cords, called "plies", along which (between the cords and the outer tread) are laid steel strips called "belts". Steel wire loops, called "beads", hold the cords together at the plies' bottom edges. An outer layer, called the "tread", encases the carcass, and the entire tire is bound

[17] "The District Court did not question Carlson's qualifications, but excluded his testimony because it initially doubted his methodology and then found it unreliable after examining the transcript in some detail and considering respondents' [the original plaintiffs] defense of it. The doubts that triggered the court's initial inquiry were reasonable, as was the court's ultimate conclusion that Carlson could not reliably determine the cause of the failure of the tire in question. The question was not the reliability of Carlson's methodology in general, but rather whether he could reliably determine the cause of failure of *the particular tire at issue*." (from the syllabus of the decision; cf. part III of it)

[18] This is the whole text of FRE 702 as amended in 2000: "A witness who is qualified as an expert by knowledge, skill, experience, training, or education may testify in the form of an opinion or otherwise if: (a) the expert's scientific, technical, or other specialized knowledge will help the trier of fact to understand the evidence or to determine a fact in issue; (b) the testimony is based on sufficient facts or data; (c) the testimony is the product of reliable principles and methods; and (d) the expert has reliably applied the principles and methods to the facts of the case."

> together in rubber, through the application of heat and various chemicals. … The bead of the tire sits upon a "bead seat", which is part of the wheel assembly. That assembly contains a "rim flange", which extends over the bead and rests against the side of the tire. (part I of the decision)

A "steel-belted radial tire" has a "carcass", many "plies", some "belts" and "beads", a "tread", and a "bead seat" among other things. Some short definitions are provided by the text. But non-experts cannot easily visualize all this. To help them, a figure drawn from an expert publication was added to the text of the decision (Fig. 1).

So, technical names, short definitions, and this figure would help readers understand the basics of it. As to the specific case, Carlson noted that the tire's tread depth, which was 11/32 of an inch when new, had been worn down to depths that ranged from 3/32 of an inch along some parts of the tire, to nothing at all along others. He conceded that the tire tread had at least two punctures which had been inadequately repaired. In spite of this, he concluded that a defect caused the blowout.

The conclusion rested on several premises, some of which were in dispute and some were not. The undisputed premises were the following: (1) a tire's carcass should stay bound to the inner side of the tread for a significant period of time after its tread depth has worn away; (2) the tread of the tire at issue had separated from its inner steel-belted carcass prior to the accident; (3) this "separation" caused the blowout.

The disputed premises were the following: (4) if a separation is not caused by a certain kind of tire misuse called "overdeflection" (which consists of underinflating the tire or causing it to carry too much weight, thereby generating heat that can undo the chemical tread/carcass bond), then, ordinarily, its cause is a tire defect; (5) if a tire has been subject to sufficient overdeflection to cause a separation, it should reveal certain physical symptoms, four in particular[19]; (6) where one does not find *at least two* of these four physical signs (and presumably where there is no reason to suspect a less common cause of separation), one must conclude that a manufacturing or design defect caused the separation.

I wonder whether any reader has a definite opinion about this. I have none. Short definitions of crucial terms, as "overdeflection", are given; but, as it seems to me, they are insufficient to justify a belief on the cause of the accident, if one lacks the relevant expertise. By the way, as it should be clear, definitions are not restricted to terms that have a real or existing reference. One can define "overdeflection", but one can also define "phlogiston" and "unicorn".

Carlson claimed he based his opinion upon a visual and tactile inspection of the tire and upon the theory that in the absence of at least two of the four physical symptoms indicating tire abuse, the tire failure of the sort that occurred in the case was caused by a defect. In fact, he found some of those symptoms (indeed all

[19] These are the four "symptoms": (a) tread wear on the tire's shoulder that is greater than the tread wear along the tire's center; (b) signs of a "bead groove", where the beads have been pushed too hard against the bead seat on the inside of the tire's rim; (c) sidewalls of the tire with physical signs of deterioration, such as discoloration; and/or (d) marks on the tire's rim flange.

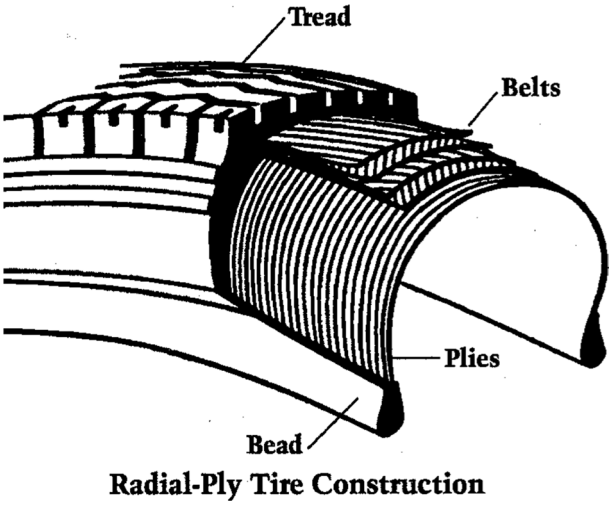

Fig. 1 From A. Markovich, *How To Buy and Care For Tires* 4, 1994

of them!) but claimed they were not significant. As the Court said, he "concluded that the tire did not bear at least two of the four overdeflection symptoms, nor was there any less obvious cause of separation; and since neither overdeflection nor the punctures caused the blowout, a defect must have done so." (ibid.)

Now, let us assume that you do not have any definite opinion about this. Presumably it is because you have some doubts on the definitions, or on the conclusion, or on that methodology of visual and tactile inspection, or on the application of the methodology to the case, or on the theory of "at least two" symptoms of overdeflection being absent. If you had any such doubt and you were to adjudicate the case, it would be appropriate for you either to exclude the evidence under *Daubert*, or to find that it does not meet the applicable burden of proof if admitted. I will discuss this in the next section.

The Supreme Court sided with the District Court on the exclusion of evidence, since the transcripts of Carlson's depositions cast "considerable doubt" on his methodology and the related theory (part III of the decision). Doubts and uncertainty need to be qualified, of course (more on this below). The concerns were "further augmented by the fact that Carlson said he had inspected the tire itself for the first time the morning of his first deposition, and then only for a few hours. (His initial conclusions were based on photographs.)" (ibid.) I spare the readers a number of other technicalities about the four symptoms.

So, how can semiotics help understand issues like this? One promising idea is to distinguish some classes of experts signs, in order to see what characterizes them. This will contribute to an understanding of the difficulties that expert evidence poses. In turn, this will help formulate indications for expert witnesses, so as to increase the likelihood that what they say will be (correctly) understood by factfinders.

First, we may take cues from Charles S. Peirce's semiotics.[20] One of his most famous distinctions in the realm of signs consists in observing that some signs resemble what they represent; Peirce called these signs "icons" and stressed that they do not necessarily represent existing things (the portrait of an imaginary character does not have an existing reference, and we can represent a unicorn or a sphinx as we represent zebras and other existing creatures). Next, as Peirce's distinction goes, there are signs that represent their reference in virtue of some physical or existential connection with it; he called them "indices" (smoke is an index of fire, a thermometer is an index of temperature, etc.). Finally, there are general signs that represent their reference in virtue of conventions or usage; Peirce called them "symbols" (words are typical examples, as "apple" refers to a specific fruit in virtue of a linguistic convention).[21] Some signs can have multiple dimensions. A photograph is an interesting case, in that it resembles its object (as an icon) and also has an existential connection with it (as an index).[22] Notice that we do not have and cannot have photographs of unicorns (but of course there can be photographs or reproductions of unicorn drawings).

How can that improve our analysis? Remember that the expert signs used in *Kumho* were basically definitions of technical terms, an illustrating figure, and (claims about) physical symptoms of past occurrences. Definitions obviously fall under the category of symbols. There are conventions under which the "beads" and the "tread" of a tire have a definite meaning. The same is true of any technical term employed in a specific vocabulary. The above picture of a steel-belted radial tire has instead the nature of an icon, in that it is supposed to correctly represent its object, by resembling it at some level of abstraction (what is represented is not a specific tire, but the kind of it, and only a part of it).[23] The iconic representation of the tire is supplemented with symbols—the words "tread", "belts", etc.—and with lines that connect these words to the relevant parts of the tire. Finally, the claims about the physical symptoms of abuse or defect point at signs that are supposed to have an existential connection to their object. These signs are indices. Still, claims about indices are not indices themselves—they are symbols allegedly representing indices that represent past occurrences such as abuse or a tire defect.[24]

What kind of advice can be drawn from the foregoing analysis? In a nutshell, when expert witnesses use symbols to provide definitions of technical terms they should do it in a way that does not result in confusion on the factfinders' side. If

[20] See especially [31, pp. 4–10] (*What Is a Sign?*, 1894); [31, pp. 267–288] (*Sundry Logical Conceptions*, 1903); [31, pp. 289–299] (*Nomenclature and Divisions of Triadic Relations, as Far as They Are Determined*, 1903). See [5] for a comprehensive account of Peirce's logic and semiotics.

[21] See [6] (arguing that generality, rather than conventionality, is the distinctive feature of symbols). Cf. [31, p. 292].

[22] See [31, pp. 5–6] (on photographs being in different respects icons and indices); [31, p. 282] (on photographs being "dicisigns" as they convey information about existent objects).

[23] Levels of abstraction do not mean that the represented thing does not exists. Steel-belted radial tires exist. But one can have iconic representations of would-be devices and also of physically impossible ones (consider Leonardo's drawings of war and flying machines, including manned flight).

[24] Such claims pointing at available evidence have, though, an *ostensive* and indexical dimension [44]. According to Peirce [31, p. 299], a claim about an existent object is a "particular dicent symbol".

technical terms are defined through other technical terms, or even through more arcane and obscure notions, factfinders will likely be at a loss. Experts should try to present things in an understandable way. This sounds pretty obvious, but legal practice shows how difficult that is. Figures, pictures, illustrations, diagrams, graphs and so forth can help the understanding of technical or theoretical claims. Factfinders need to be educated, as some scholars claimed [4], since blind deference is problematic and is pointless when experts disagree.[25] If experts do not educate the factfinders, the burdened party is likely to lose. So, to that purpose, icons can add to symbols and vice versa. An image with no verbal explanation often tells too little, while technical explanations unsupported by visual devices can result in insufficient understanding. The most difficult point concerns indices, as *Kumho* shows.

Much of Carlson's proffered testimony in *Kumho* turned on his ability to detect the four "specific, physical symptoms" indicating tire abuse, and on the theory of those symptoms. Such "symptoms", in Peirce's vocabulary, would be indices. They are signs showing an existential connection with their object, that is, tire abuse. When those indices are present and the expert can detect them, one can conclude—according to Carlson's theory—that tire abuse occurred. When those indices are absent or only slightly present, one can conclude that something else caused what happened. It followed for Carlson that most probably a defect was the cause of the accident in the instant case.

Some comments are in order. First, notice that indicating such symptoms on the actual tire or showing that they are absent is just a part of the story. Theory without ostension is void, but ostension without theory and inference is blind. So, second, ostensive acts and actual indices must be supplemented with adequate theory and inference. And here were some of the weaknesses of Carlson's approach. It was unclear why in the absence of at least two of the four signs of tire abuse (why at least two?) one should conclude that a defect would be the best explanation of the accident. And it was unclear how he could dismiss the slight presence of some of those very symptoms—the four of them indeed! There were in fact indices of abuse, the very signs that would matter according to his own theory, but he claimed they were not significant. This claim appeared to be ad hoc, absent a better explanation. Third, ironically, his expert argument was structured as probatory arguments should be, that is, as an inference to the best explanation [28].[26] Having excluded tire abuse, and absent any evidence of a less obvious cause, he concluded that tire defect was the best explanation of what happened. In principle he followed the right methodological path. In fact, as already pointed out, there were flaws in his argument. Fourth, one of the flaws was the fact that his initial conclusions were based on photographs and he had inspected the tire itself for the first time the morning of his first deposition. Photographs are both icons and indices, for the reasons mentioned above.

[25] See, however, [34] and [20] on "critical deference" (discussing [47]).

[26] That is not only a scholarly point. One can find it in significant judicial decisions. As an Italian exemplification, consider that under *Franzese* (Cass. sez. un. penali, no. 30328/2002) it is required, for the proof of causation in criminal cases, not only that the prosecution's hypothesis be the best causal explanation of the evidence and of the known facts, but also that the alternative causal patterns (alternative explanations) be excluded as implausibile or unwarranted.

They certainly have probative value. But inspecting the real thing has more importance than inspecting photographs of it. What has been called "Principle of Maximal Proximity" [44, pp. 148–150] recommends exactly this: go as close as possible to the facts of the case, to what Locke termed the "Original Truth". A photograph is also an index, but in *Kumho* the argument was about the presence or absence of indices in the real thing, namely the tire. Being satisfied with a photograph when the original thing can be inspected is certainly inappropriate.

We can take additional cues from the work of Ruth G. Millikan on natural and intentional signs.[27] Smoke is a natural sign of fire; black clouds are a natural sign of rain. Smoke and clouds carry natural information. As natural signs they cannot be wrong. Only intentional signs can (more on this below). What Millikan [24, p. 31ff] stresses is that logical and natural necessity are not required for a sign to be a natural sign carrying natural information. One of her examples is the detection of tracks that can be left both by quail and pheasants. Whether or not there are pheasants or quail in a given place is a matter of statistical frequency, not natural law. It is a local affair. Millikan claims that in such cases the relevant signs are "locally recurrent" natural signs. Also, one can produce a photograph of some such tracks; it will be the sign of a sign, as a form of semiotic embedding. There are channel conditions that go from the animal to the photograph through the tracks, and one can go backwards from the photograph to the animal through the tracks (performing an abduction, that is generating an explanatory hypothesis on what left the tracks). That exploits embedding in natural signs. But the farther you start from the "Original Truth", the harder it is to track the right signs and the right route.

Let us take *Kumho* once again. Specifically, the causal routes in dispute were two: (1) from tire abuse, through overdeflection and its symptoms, to technical tire "separation" and the blowout; (2) from design or manufacturing defect, without overdeflection, to tire "separation" and the blowout. Whether the first or the second was true was not a matter of definition or expert terminology, nor of pictures in the abstract. It was a local affair, possibly revealed by those symptoms as natural signs carrying information. But a theory was needed to make sense of those symptoms or of their absence, since the affair was not as simple as the smoke and clouds examples. To "read" such natural signs you need a theory or at least some expertise obtained by training. Millikan articulates this with respect to the medical field:

> In many fields of knowledge, becoming an expert involves learning to recognize subtle perfectly diagnostic signs for a variety of different kinds, that is, local signs outside of whose boundaries one doesn't traverse. Or it may involve learning how to track various causal streams of signs. The modern doctor diagnosing signs of infectious diseases will be helped by understanding as much as possible about what causes the spread and the boundaries of each disease. [24, p. 42]

Once a theory is in place, in Peirce's terms there are symbols that make sense of the indices; in Millikan's terms there are intentional signs that make sense of the

[27] See especially [24] (cf. [16]). See also [25].

natural ones. The conventional forms of language go hand in hand with the possibility of forming intentions and using intentional signs. But intentional signs, unlike the natural, can be wrong. They can be false. They can be used to mislead. Remember there have been theories about witches, demons, and a number of alleged things like phlogiston.

So, ostension of indices (or natural signs) is necessary to expert knowledge transmission. But theory and inference (made of symbols, or intentional signs) are necessary as well. If icons too are available they contribute to knowledge and understanding. However, there are no magic recipes. Theories and inferences can fail to represent. Icons can represent things that do not exist. And indices can be read in ways that are misleading. If there is a piece of advice for expert witnesses, it is to pay more attention to the merits and limits of the signs they use. Obscure terminology and unexplained assumptions can be devastating. Experts should educate factfinders, but someone should educate experts in being clear in the ostensive acts and the inferences they perform. As they should know, if you don't explain yourself you do your best to lose.[28]

4 Expert Testimony and Burdens of Proof

After clarifying those semiotic aspects of the matter, it is now time for seeing the impact of burdens of proof on expert evidence issues. A couple of telling passages in *Daubert* signal that admission of dubious evidence can be cured by litigation devices such as burdens of proof and related instructions.

> Cross-examination, presentation of contrary evidence, and careful instruction on the burden of proof, rather than wholesale exclusion under an uncompromising "general acceptance" standard, is the appropriate means by which evidence based on valid principles may be challenged. (syllabus of the decision)
> Vigorous cross-examination, presentation of contrary evidence, and careful instruction on the burden of proof are the traditional and appropriate means of attacking shaky but admissible evidence. (part III of the decision)

These passages were meant to justify the departure from *Frye* (from the "general acceptance" standard as a necessary condition of admission) and, at the same time, they were supposed to mean that under *Daubert* judges are not going to invade the province of the jury. Once judges discharge their gatekeeping responsibilities, admitted evidence will be presented to the jury. In the adversarial model of litigation, that includes the possibility of cross-examination and presentation of contrary evidence, and leads to a jury decision on the merits based upon the relevant burden

[28] Notice also that the use of expert signs in legal texts generates the problem that Canale [9] calls "opacity of the law" (a problem going far beyond factfinding). For a distinction between epistemic deference and semantic deference, see [45] (claiming that the former is an appropriate judicial attitude, whereas the latter is not because judges must maintain control of the legal consequences of the concepts applied).

of proof. This is the cure against "shaky but admissible evidence" (assuming that fakes and junk have been rightly excluded). Cross-examination provides in particular the opportunity to ask critical questions, if critical points have not been addressed earlier.

Now, all of that has only a partial parallel in civil law jurisdictions and bench trials. Where judges are the only factfinders there is no such division of labor, and judges decide both on evidence admission and the merits of a case. In the traditional Continental phrase, when facing (conflicting) expert evidence the judge must become a *peritus peritorum*, namely the expert of the experts.[29] In a sense, a *superexpert*. Or a referee more than a filter. That fuels the usual concern: How can legal factfinders make decisions on expert matters that they likely ignore or misunderstand?

Daubert helps higher judges of Continental jurisdictions to perceive themselves as solely concerned with methodological issues and reliability.[30] But trial judges must decide on the merits, and, when they idealize science and have a poor understanding of it, they likely become too harsh or too generous toward scientific experts, either because they ask too much from science or because they accept uncritically the experts' claims. The latter risk is particularly acute with court-appointed experts. In Continental systems it is much frequent to have independent experts appointed by judges and conceived of as their "aides" [22, p. 835]. But commentators and authorities on the Continent stress the risk of overconfidence placed by judges in independent experts.[31] At the same time, the discussion carried out in common law countries usually concerns partisan experts, given the entrenchment of the adversary model of litigation in the American system in particular. Still, according to some commentators (more on this below), the troubles in establishing the reliability of partisan testimony and its admissibility should have the effect of strengthening the use of independent experts (as FRE 706 allows).

Hence, the case is not *Superexpert v. Gatekeeper*. This would be a false start. Nor is the case *Independent v. Partisan Expert*. This too would be a false start. Differences in legal systems and in procedural devices should not obfuscate the basic point: expert signs and testimonies frequently generate an epistemic or doxastic impasse. Factfinders cannot form a justified belief, nor can they say whether they have acquired the relevant knowledge. When this impasse is the case, it is because factfinders (be they jurors or judges of various sorts) do not understand expert testimonies (be they independent or partisan) or because they have significant doubts about them.

A way out of the impasse is provided by legal burdens of proof. Legal systems properly deal with that impasse by applying burdens of proof rules and deciding

[29] This traditional view was maintained in an important Italian decision such as *Cozzini* (Cass. IV sez. penale, no. 43786/2010) § 14.

[30] In this perspective *Cozzini* (§ 16) multiplied Daubert's factors providing a long list of criteria of genuine science and stressing that they are just illustrations of it.

[31] A recent Italian decision (*Pavan*, Cass. sez. un. penali, no. 14426/2019) has made it clear that expert opinions should not be accepted without adversarial scrutiny and critical examination, even when they come from independent experts.

accordingly. We need to see first what those burdens amount to, then we will be able to appreciate their impact on issues over expert signs and evidence. As a caveat, remember that procedural arrangements can make a difference as to the way in which the burden logic is applied. Still, this logic generalizes to different jurisdictions.

According to the American literature in particular, three kinds of burden can be imposed upon a party at trial: (1) the burden of pleading, (2) the burden of production, and (3) the burden of persuasion.[32] The second and third constitute what scholars call "burdens of proof".

Ron Allen [3, p. 9] claims that *burdens of pleading* "specify the conditions under which factual/legal issues will be deemed to be included within a litigated case. They can be distributed any way the law maker prefers, although usually they are allocated to the party asking for a change in the *status quo*." They create the "scaffold of the trial" [3, p. 9], but generate no interesting conceptual challenge according to Allen.

Burdens of production pose a party before an alternative: either the party produces sufficient evidence to go on with the proceedings, or it loses the issue or the entire case. Further litigation is unjustified if insufficient evidence is produced. Therefore, "the burden of production informs the parties how issues will be decided if no or inadequate evidence is produced" [1, p. 198]. *Burdens of persuasion* specify instead the evidentiary thresholds that govern the decision on the merits. "A burden of persuasion informs the decision maker how to decide a case in light of the implications of the evidence." [1, p. 199]. The "beyond a reasonable doubt" threshold constitutes the criminal burden of persuasion in many jurisdictions; [33] the "preponderance of the evidence" threshold constitutes the civil burden of persuasion in many jurisdictions.[34]

It is common understanding, in that literature, that burdens of production are a function of burdens of persuasion,[35] in that the latter set the evidentiary threshold in light of which the former are satisfied or not. Here is a clear account of this:

> The measure of whether a burden of production is satisfied is, following the presentation of evidence, whether there remains a triable factual question—whether, in other words, further proceedings regarding that fact are in order. That depends both on the state of the evidence, but critically as well on the burden of persuasion. If a party with the burden of production produces some evidence of a factual issue, but no reasonable person could find for that party, given the burden of persuasion, then it is pointless to expend further resources

[32] See [37], [3], [1], [36, p. 219ff], [23]. For a different categorization, see [33] (distinguishing burdens of persuasion, of production, and tactical burdens).

[33] Cf. [43] for a comparative analysis.

[34] Some scholars rather take those thresholds as "standards" of proof. The label "standards of proof" emphasizes the epistemic dimension of the matter, as I understand it, while "burdens of proof" emphasizes the procedural one. The two labels emphasize different aspects of the same legal technique of dispute resolution. Cf. [37].

[35] The first to make the claim explicit was [23]. Burdens of persuasion impact also other aspects of the litigation process (cf. [1, pp. 202–203, 206–210], [3, pp. 10–13]); I leave this aside.

> on that factual issue and judgment should be entered accordingly (however this is done in each idiosyncratic procedural context). [3, p. 9]

So, there are conceptual and procedural differences between those burdens but there also are connections between them. One of the connections is that burdens of production depend on burdens of persuasion in the sense specified above. Notice in addition that the law can allocate burdens in a variety of ways, and can use presumptions to allocate or shift them. In other words, burdens of proof are techniques of risk allocation [35, p. 224ff]. Before returning to our main argument, let me also point out that those burdens or similar ones exist in other jurisdictions under different names.[36] This is important to generalize the argument that follows.

When a burden is not discharged, an adverse decision is in order. This sort of *normative asymmetry* is as simple as necessary to decision-making. In this sense burden rules govern the outcome. The point is straightforward with respect to burdens of persuasion. If a persuasion burden is not discharged, the decision must be against the burdened party. A couple of qualifications are needed, though, to make the argument compelling. First, it must be the case that no additional (non-expert) evidence is sufficient to satisfy the burden. If such evidence existed and was presented to the factfinders, there would be no justified epistemic or doxastic impasse (even if the expert evidence puzzled the factfinders). Second, factfinders must exert their cognitive and inferential powers to their best. Unmotivated and unjustified concerns or doubts do not matter. If factfinders exert such powers to their best and the expert signs remain puzzling or problematic in some respects, there is reason to think that the burden was not discharged. When the (competing) expert testimonies result in a doubtful situation and doubts are justified, the burden has not been discharged. Then an adverse decision is justified. Of course, "to their best" must be read in light of the time and resources constraints. As pointed out in Section 1, factfinders do not have the privilege of postponing indefinitely the resolution of a dispute. Notwithstanding the expectation of acquiring a clearer understanding of the relevant matters if they spend more time studying them, they have to live by the limitations and constraints that the law poses.

That is pretty clear with respect to criminal cases governed by the reasonable doubt burden.[37] If the case of the prosecution results in a reasonable doubt, decision against the prosecution is in order. In a civil lawsuit under the preponderance of evidence burden, an adverse decision is justified if the relevant doubts prevent the factfinders from thinking that the case of the burdened party prevails on the preponderance of the evidence. To put it another way, if the expert testimony supporting the burdened party is not capable of imposing itself as the best explanation of the evidence [28], the burdened party loses. This is clear in civil cases where the preponderance of the evidence is the burden of proof. *A fortiori* it holds of criminal

[36] Cf. [7, p. 23ff], [27], [30], [40, p. 345ff], [29, p. 77ff]. Civil lawyers often discuss the distinction between *subjective* and *objective* burdens of proof, which parallels to some extent the one between burdens of production and of persuasion (I cannot address the point here).

[37] Differently put, the traditional "in dubio pro reo" principle prevails over the "free assessment" of evidence.

cases where, to meet the reasonable doubt burden, the best explanation must be without plausible rivals compatible with the defendant being innocent.

Note that the move "I don't understand, so I make an adverse decision" too easily lends itself to abuse. Factfinders can become lazy or indulge in some bias against expert signs. The above qualifications (no other evidence available and sufficient, and cognitive and inferential powers exerted at their best) serve the purpose of avoiding that.

More theoretical effort is needed to see the point about burdens of production. A simple claim would be that, being burdens of production a function of burdens of persuasion, an adverse decision is justified when a burden of production is not satisfied in light of the applicable burden of persuasion. However, to make sense of cases like the Daubert trilogy, we need to articulate the relations between admission burdens (showing relevancy and reliability) and burdens of proof. My understanding is this: if expert evidence is not admitted (because unreliable, say) and no other evidence (or too little) is adduced, then the burden of production as a function of the burden of persuasion is not discharged and the burdened party loses. This also shows that the category of "legal burdens" goes far beyond the subcategory of "burdens of proof". There are burdens of pleading, admission burdens, other argumentative or tactical burdens, and burdens that belong to substantive law (e.g. to get a driver's license you must satisfy some definite conditions).

It is of course important to know what the burden of persuasion is, but the basic structure of the decision-making process does not depend upon a specific burden, nor on its specific allocation. Suppose a court has to adjudicate the case of someone who got health problems while imprisoned, and suppose that, with a presumption in favor of the claimant, a burden of persuasion is shifted onto the State. This would mean that if a person goes to jail with no health problems and then something bad happens to her (not necessarily torture), then the State has to show why the person got ill (the relevant authorities have in principle the best information about what happened, including expert information provided by medical authorities). If this burden is not discharged the State is liable. Here the person has a burden of production (evidence of the disease) and the State has a burden of persuasion (explanation of the disease).[38] Now, for a reasoned decision it is certainly important to know whether the burden of persuasion is the reasonable doubt one or something different like the preponderance of evidence; in one scenario, the State is liable unless it is proven beyond reasonable doubt that the person's illness was unrelated to officials' behavior; in the other scenario, the State is liable unless that is proven by the preponderance of the evidence. But in both scenarios burdens of proof regulate the outcome. Suppose the medical information provided by the State is dubious, or factfinders cannot understand it or some important parts of it even exerting their cognitive and inferential powers at their best; then the State is certainly liable under the reasonable doubt burden, and possibly under the preponderance of evidence burden.

[38] Or, more specifically, one could say that the claimant has the burden of production *and* persuasion with respect to the existence of the disease, and the respondent has the two burdens with respect to what was the cause of that disease.

A significant part of the literature discusses some possible changes in the actual procedural devices, and compares the related solutions to the problem of expert signs and expert evidence.[39] One orientation is favoring the education of factfinders over deference in expert matters [4], possibly changing some procedural devices in order to facilitate education of factfinders by experts; some scholars insist on dialogical mechanisms to reduce the information deficit, or on alternative modalities of soliciting information from experts—one possibility is to relax the adversarial dynamics of trials and reduce partisanships among expert witnesses; [40] other views focus on the use of expert factfinders (constituting panels of biologists, say); some proposals combine those features (having experts as "assessors" of decision-making bodies). Are solutions as those worth their costs? It is hard to say, but possibly yes. To different extents, they would likely reduce the percentage of doubtful or problematic cases; but in doubtful cases the legally appropriate outcome would remain the same, namely decision against the burdened party.

Some scholars insist instead on the use of independent experts. Richard Posner [32] focused on the testimony of economic experts and provided a model taken from arbitration. His discussion starts from some concerns over expert testimony in an adversarial context: (1) expert testimony is affected by excessive partisanship; (2) it can mislead the factfinders more readily than lay testimony; (3) there is a risk that, if partisan experts cancel each other out, the case is decided on non-expert evidence (which would be a loss for the parties, for their expenses in expertise would have been useless). Let us pause on his responses to those concerns.

Posner thinks that (1) is overstated, when there is a substantial professional consensus, also because: (a) as repeat players, experts have an interest in creating and preserving a reputation; (b) if they have a record of academic publication they also have a disincentive to repudiate their work (cross-examination would be devastating)[41]; (c) the adversarial system guarantees intense critical scrutiny of the evidence; (d) an expert opinion is not admissible if it does not meet the methodological standards in the expert's field.

Also (2) is overstated for Posner, because lawyers have an incentive to call persuasive witnesses. Some subjects, like econometrics, are really difficult for non-experts to understand; this can be mitigated with court-appointed experts, as independent and neutral experts contrasted with the partisan ones (factfinders will be likely persuaded by the former, even if they do not fully understand what they claim). This insight comes from the arbitration model endorsed by Posner, according to whom concern (3) too will be alleviated if a neutral expert is selected by the opposing parties. A common method of selecting arbitrators is for each party to choose an arbitrator and for the two arbitrators to then choose a neutral one, who generally casts the deciding vote. Posner's proposal is that judges appoint an expert selected by the

[39] Some of these options are discussed long since. See [19]. Cf. [46], [47], [18].

[40] See [11] (expressing also critical reservations on the effectiveness of some strategies as pretrial meetings and "concurrent evidence" sessions—a.k.a. "hot tub").

[41] As a consequence, a warning flag should go up when the expert has no such record.

parties. But more troubles arise in the areas of economics that lack professional consensus, such as antitrust.[42]

As another scholar has pointed out [13, p. 105], economics is not empirical as the hard sciences and "economists are more like the car tire experts in *Kumho Tire* than the biologists in *Daubert*". "The troubled relationship between *Daubert* and economics culminates in antitrust cases" [13, p. 105] given the following methodological problems: (1) in antitrust matters there is little empirical testing; (2) error rates are hard to know; (3) publications diverge; (4) antitrust cases are "theory-driven", for theoretical content is needed to interpret and apply antitrust provisions. For instance, what do we mean by "anticompetitive effects" and "abuse of a dominant position"?

Another proposal that has been advanced is to go back to *Frye* in criminal law, not for both parties but in a fashion that will best protect criminal defendants. Alex Stein [38, p. 196] observed that in England courts take an extremely liberal approach to the admissibility of expert evidence. His advice is to better define the stakes and focus on the moral issue of the allocation of the error risk, on which science has no say. His principle of maximal individualization of the evidence [38, p. 91ff] bars expert evidence which is not susceptible to individualized testing and is offered against the defendant; on the other hand, criminal defendants "should be allowed to put forward any expert evidence, which the fact-finders will evaluate in terms of its case-specific probative value." [38, p. 197]. For Stein, here *Frye* is better than *Daubert* on moral grounds: it provides the best feasible protection for criminal defendants. As to expert evidence in civil litigation, instead, according to Stein admission should not generate unjustified allocations of the error risk. Falsifiability, in particular, is important because falsifiable testimony cannot classify as one-sided [38, p. 237]. But what if experts disagree? Court-appointed experts would be welcome for Stein.[43]

Again, proposals like Posner's and Stein's would likely reduce the percentage of problematic or doubtful cases, but in doubtful cases the appropriate outcome would remain the same: decision against the burdened party, when the burden is not discharged. This asymmetry is as simple as necessary to legal factfinding.

[42] See [13] for an empirical confirmation of the concern about antitrust experts, since "antitrust economists testifying for the plaintiff have approximately a one-in-two chance that at least part of their opinion will be excluded—an abnormal percentage in comparison to other disciplines, including other areas within economics" [13, p. 103]. Giocoli points out that in antitrust cases even some Nobel laureates have been excluded under *Daubert*!

[43] "Under the equality principle, when the parties' experts disagree in their evaluations, adjudicators appoint and normally accord preference to a court-appointed expert. By pre-empting the potentially partial accounts of adversarial experts, testimony given by such an expert functions as best evidence as a matter of law." [38, p. 237]

5 Conclusion

It is certainly frustrating to be unable to understand expert signs and be, at the same time, the factfinder in a legal dispute. This problem has originated an enormously vast amount of literature, as the present work tried to indicate. Part of this literature has been fueled by judicial decisions like the "Daubert trilogy", for these decisions have addressed some crucial problems and concerns over the use of expert testimony in legal disputes. Most of these problems, certainly the epistemological ones, affect trials all across the board of different jurisdictions and legal systems. In this sense their reach is "global". The present work focused on one of these problems, namely on the epistemic or doxastic impasse experienced by factfinders when they do not understand the experts signs they are provided with by expert witnesses, or when they do not understand some important parts of expert testimonies. When this is the case, factfinders cannot form a justified belief on what happened, or cannot accept in a justified way a given expert claim about the relevant facts. I have examined one case in particular (*Kumho*) to give a detailed idea of the issue. And I have provided a legal and semiotic analysis of it. Notice that deference to the expert might be an option when factfinders cannot understand the evidence. But this is no solution when experts disagree or when lack of understanding results in the case being doubtful.

That, however, does not result in a decisional paralysis. The law has a traditional way out: decision against the party with the burden of proof, when: (1) factfinders make their best effort to understand what they are given, and (2) the case remains doubtful also because no other (non-expert) evidence helps the factfinders. I have tried to spell out some of the details of this by articulating the different burdens of proof that can be imposed upon a party at trial, and relating them to other legal burdens.

There are possible configurations of procedural devices that are likely to reduce the number of dubious or problematic cases with respect to expert signs. I have mentioned some of them. It is possible that, without some such reforms, legal systems continue to generate a high percentage of false negatives in expert cases. This probably results from the straightforward application of the burden rules in doubtful cases. Still, the claim holds good that for whatever reduction of the doubtful cases, in the remaining ones the appropriate legal outcome remains the same: decision against the burdened party, when the burden is not discharged.

One may think that this approach is a way of avoiding the problem. Perhaps it is, but then one has the argumentative burden of showing that there is a (better) solution to the problem. Or, as I am inclined to think, the burden strategy is a procedural solution to a substantive problem, and it is the best we have.

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