

How judges (should) deal with scientific evidence

Marco Cecchi*

HOW JUDGES (SHOULD) DEAL WITH SCIENTIFIC EVIDENCE

ABSTRACT: How should scientific evidence – or rather, a scientific hypothesis – be treated by the judge (or juror) who deals with it? Without dwelling on how this type of evidence enters the trial, the paper will expand on the judicial evaluation of scientific evidence. The Author retains that the ‘reinforced reasoning’ approach (a decision method structured by necessary steps, made up of arguments concerning salient aspects of the case under examination and which must be appreciated in order to decide) is also applicable in this matter.

KEYWORDS: Reinforced reasoning; grounds of the judgment; scientific evidence; expert witness; innovative DNA Panel

SUMMARY: 1. Introduction – 2. The Paradox of Specialist (espec. Scientific) Evidence – 3. Beyond the Paradox – 4. How Judges (should) Deal with Scientific Evidence and Scientific Hypotheses. Reinforced Reasoning on Science – 5. An example. About an Innovative DNA Panel associated with New Technology named Next Generation Sequencing

1. Introduction

We live in societies where social relationships and human knowledge (of the world and of ourselves) become, year by year, more interconnected and complex. Although at different rates of development, on the one hand, relations and opportunities for encounters – and, therefore, possible clashes – between people with particular and often conflicting interests are multiplying; on the other hand, human understanding of phenomena is growing and becoming more specific, with deeper and more detailed studies that explore and explain more closely the laws and mechanisms by which human beings and the universe work. This gradual intensification of the connections between people and this tendency to ‘miniaturise’ the level of cognitive analysis of things¹ also has repercussions within the legal system. For example, new regulatory needs are flowing in – like never before – which exacerbate legislative action; sources of law are proliferating, even in previously unknown forms (*e.g. soft law*), with consequent problems of

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¹ M. PASSAROTTI, *There are no genius languages, but only genius Authors*, in *Corriere della Sera*, December 23, 2018: “One of the characterizing features of 20th century research has been the miniaturization of the level of analysis. We can think about physics, biology, or chemistry: new instruments, such as the microscope, make it possible to enter for the first time into the depths of the objects to be investigated”.

interaction between the different provisions and types of regulations; the legal issues that need to be addressed and resolved are becoming significantly more complicated; and so on.

As far as it is of interest here, with reference to the complexity of the legal issues and problems to be addressed and resolved, we note that in today's court proceedings there is a greater presence of experts than in the past. The establishment – through evidence – of the facts, to which the law is then applied, now almost always presupposes the possession of (or, at least, the ability to manage) specific technical, scientific or artistic skills.

Today, many profiles and salient aspects of legal disputes require, in order to be resolved, the involvement of a science expert – although not decisive, since the judge has the last word in any case: see below, par. 2. The voice and writings of the scientist (to be understood in a broad sense, as anyone having specific technical, scientific or artistic skills), come along with all other evidence introduced in the trial; and, added together, they constitute that body of evidence, based on which the parties argue their case and the judge takes the final decision.

Thus, more frequently than in the past, the problem arises as to how the jurist – particularly the judge – should evaluate the technical information brought by the expert into the proceedings, i.e. the so-called specialist (or, *lato sensu*, scientific) evidence.

2. The Paradox of Specialist (espec. Scientific) Evidence

The situation is, at least apparently, paradoxical.²

At first, the jurist 'asks for help' from the scientist, because the ascertainment of the facts requires specialist knowledge. Once this contribution is introduced into the proceedings, however, non-experts (i.e., the judge, the lawyer, the prosecutor) magically become able to appreciate the technical knowledge put forward by the expert, since they are *ex lege* obliged to evaluate and express their opinion on this kind of evidence.

From now on, we will focus on strictly scientific specialist knowledge.³

In this regard, we note that, in terms of evaluation, no particular problems actually arose as long as the old positivist conception of science was in force. The *ipse dixit* of the scientist – as a repository of knowledge considered unlimited (general and absolute), unique and infallible – directly founded the

² M. TARUFFO, *Considerations on Science and Civil Trial*, in G. COMANDÈ, G. PONZANELLI (eds.), *Science and Law in the Prism of Comparative Law*, Turin, 2004, 492: "The paradox lies in the fact that the consultant is appointed when, based on a rigorous self-assessment, the judge establishes that it lacks the technical or scientific knowledge required for the decision. However, and still in this situation of cultural deficiency, the judge will be in the position of having to evaluate the outcome of the expert opinion in order to determine whether it is worth using for the purpose of the findings of fact. In essence, the judge is supposed to be able to make an *ex post* assessment of technical and scientific knowledge that it did not possess *ex ante*".

³ For our purposes, by 'science' we mean "a type of knowledge characterized by the following: it has as its object the facts of nature; it is ordered according to a set of general rules called scientific laws, and linked together in a systematic way; it uses a method controllable by scholars in the formulation of the rules, and in the verification and falsifiability of the same" (P. TONINI, C. CONTI, *Criminal Evidence Law*, Milan, 2014, 164).

legal decision. The jurist had no choice but to appoint an expert and slavishly submit to the latter's conclusions.⁴

Around the middle of the 1900s, things change: post-positivism and falsificationism bring a paradigm shift. The assumption of the fallibility of science⁵ deeply transforms the jurist's approach to the evaluation of the words coming from the mouth of scientists. There is no longer any epistemological requirement to conform to the findings of the technical advice, which can now be undisputedly – if reasonably, of course – disregarded.

With reference to the judge, the figure of the *iudex peritus peritorum* is spreading.⁶ The judge is fully entitled to depart from the technical findings and the considerations of the expert witness, provided that adequate reasons support that choice. The scientific evidence is subject to the judge's autonomy of assessment, just – *mutatis mutandis* – like any other evidence.

How is this possible, in practice, without the judge's decision resulting arbitrary but, instead, scientifically supported? Given the divergence between the judicial and the scientific work,⁷ how can the

⁴ We note in passing that this way of proceeding cannot be considered completely outdated: it is still – and not so rarely – practiced both in criminal and, above all, in civil matters. In the field of criminal law, in order to curb – in general, and not just in relation to the issue at hand – this passive acceptance of the considerations of others, multiple law reforms and case-law rulings have, in time, tightened the obligation to state the reasons for the decision. For example, Law no. 47 of 2015 has introduced the obligation of "autonomous assessment" of certain prerequisites for the application of precautionary measures. It was considered necessary to make this requirement – intrinsic, in truth, to the judicial activity – explicit and reflected, on pain of nullity, in the grounds of the order. This legislative reform aimed at contrasting the distorting practice of copy-paste, through which the judicial decision became a sort of collage, given that it followed the request of the public prosecutor (which in turn may be based, in part or completely, on the police report), without making an independent assessment on the merits of the request. Similarly, in case law – starting from the Primavera case (Crim. Cass., Joint Div., June 21, 2000, no. 17, Primavera, in *Cass. Pen.*, 2001, 69) – the Court ruled that the reasoning should not slavishly refer to other acts, in order to avoid that the activity of *reddere rationem* is reduced to a mere activity of copying other people's thoughts, not personally assessed/processed. In this sense, for the reasons to be lawfully stated *per relationem*, it is necessary that "i) the decision makes reference to a lawful act of the procedure, the reasons for which are consistent with the need to justify the decision to which it relates; ii) the decision provides evidence that the judge has taken cognizance of the substantive content of the reasons of the decision of reference and has weighed and considered it consistent with its own decision; iii) the reference act, if not attached to or quoted in the decision, is however known or at least accessible to the interested party".

⁵ According to the post-positivism approach, science is seen as limited (humans cannot grasp and explain all aspects of a phenomenon), plural (there are multiple methods of scientific research and analysis) and fallible (carrying a rate of error; and, if disproved, surmountable).

⁶ On this topic, in a criminal-procedure perspective, see G. CARLUZZI, *Iudex peritus peritorum*, in *Dir. pen. cont.*, 2017, 2, 27 ff. (also cited as a reference in the bibliography). According to the author, "the formula [*iudex peritus peritorum*] is the specification, in the field of 'specialist evidence', of the principle of free conviction, and it is justified not so much by (an improbable) confidence in the omniscience of the judge, as by consistency with the decisional role that the law assigns exclusively to the judiciary" (28).

⁷ The scientist empirically identifies certain (perfectly reproducible) categories of facts and studies, experimentally, their relationships and the way in which they constantly occur, in order to derive laws of general application, which are valid until proven wrong. On the other hand, the judge reconstructs – by means of evidence, including scientific evidence – a human event in the past (a historical fact that cannot be reproduced in the same terms: a *lost fact*), in accordance with the rules of procedure, in order to apply the law to the specific case and to issue a decision of individual scope, which is binding on that particular legal addressee and which, once it has become final, cannot, normally, be overturned. While the cognitive act aimed at by the scientist is purely descriptive-cognitive, the one aimed at by the judge – and achieved through the decision – is essentially per-

judge (non-specialist) communicate with the consultant (specialist) and be able to understand the latter's statements, so as to translate them into 'legal language'?

3. Beyond the Paradox

The paradox, in truth only apparent, is overcome by the so-called processualization of specialist knowledge.

When it enters the courtroom, science must follow the legal procedure – and epistemology. This does not mean that the contribution that the scientist brings to the proceedings is or should be legally influenced. The content of the technical report is – and remains – in the full and exclusive availability of the expert who drafts it. Conversely, the way in which the scientific evidence enters the proceedings and is evaluated by the jurist is definitely outside the expert's area of competence.

It is a matter of constitutional legitimacy: only the cognition (which then becomes deliberation) of the judicial authority can be the basis of a measure having binding force. This choice of field, which cannot be withdrawn except for revolutionary events, founds the legitimate use of powers on the Rule of Law that underpins our constitutional State.⁸ For this reason, the outcome of the trial assessment, and, therefore, of the judge's binding decision, cannot exclusively depend on technical evidence, which is "the result of scientific knowledge that does not, cannot and should not belong to the judge".⁹

Moreover, and in the same perspective, the court appraisal (inherent in the exercise of jurisdiction) is also indispensable for reasons of logical and material consequentiality. In fact, whilst science offers a valid support to the reconstruction of the facts, the decision ending the proceedings is, however, the result of at least one further mental step, at least one other inference that involves a complex assessment and does not automatically descend from scientific hypotheses.¹⁰ In this sense, as stated by the Italian Supreme Court (in the Cantore judgment – 2013), we can say that the judge, with the help

formative-imperative and not just descriptive-cognitive. The foundation of scientific laws lies in the 'world of being', in which relations of truth/falsity are configurable; the foundation of legislation lies in the 'world of ought-to-be', where we find relations of legitimacy/illegality and lawfulness/unlawfulness. Moreover, while a scientist can suspend judgement and declare a problem unsolvable at the moment, on the contrary, the judge must necessarily take a decision at the end of the proceedings, which take place within a well-defined time period (P. TONINI, C. CONTI, *Criminal Procedure Handbook*, Milan, 2021, 265 and nt. 78-79; *amplius*, 263-271).

⁸ The jurist – and in particular the judge – must therefore make the science introduced into the process by the expert its own, because only with the legal categories is it possible to finally complete – or contribute to completing, when the jurist is a party to the proceedings other than the judge – the activity of *ius dicere* in compliance with the Italian Constitution (Articles 101, 102, 108 and 111).

⁹ These words are taken from the Court of Cass. Criminal Div., Sec. V, September 7, 2015, case no. 36080, Knox-Sollecito, in *CED Cass.* no. 264863 (where, significantly for the purposes of this paper [see par. 4.], immediately after it is noted that this non-belonging "is all the more true with respect to genetic science, whose complex methods postulate a specific knowledge in the field of forensic genetics, chemistry and molecular biology, which belong to a wealth of knowledge that is light years away from the training, purely humanistic and legal, of the members of the judiciary").

¹⁰ These further mental passages may be related to the reconstruction 'in fact' (*quaestio facti*), in which – in addition to scientific laws and as a last inferential step – recourse is made to common experience, or to the reconstruction 'in law' (*quaestio iuris*), in which we pass from the 'world of being' to the 'world of ought-to-be' and the value judgments to be made are of a purely legal nature (see nt. 7).

of experts, is required to identify the accredited knowledge that can guide the decision and, after metabolizing its complexity, make judicious use of it and make it legally accessible: that is, understandable to anyone, conformable to reason and humanly plausible. The expert is no longer – and should never have been – the arbiter who decides the trial, but the expert who provides the scientific context in the area involved in the judgment, in the knowledge that the final word will be left to the judge.¹¹

The issue of the processualization of specialist knowledge concerns both the manner in which scientific evidence enters the proceedings (*i.e.*, the admission and taking of evidence and the role of the representatives of the parties in this process) and its evaluation. However, as mentioned above, here we will exclusively focus on the second aspect; and, more specifically, we will turn our attention to evaluation as a basis of the judge's decision. Furthermore, although our considerations stem from the developments in the criminal field,¹² they may be applicable to other branches of law as well; in particular, to civil matters. Whilst the evidentiary standards required are different (*e.g.* beyond a rea-

¹¹ We already made these considerations in M. CECCHI, *The 'autonomous evaluation' of the judge as a bulwark against uncritical use of scientific evidence*, in *Dir. pen. proc.*, 2017, 919 and 921-922 (where we also refer to *Crim. Cass.*, Sec. IV, January 29, 2013, no. 16237, Cantore, in *Cass. pen.*, 2014, 1670). In essence, what the jurist – in particular, the judge – is unable to transpose and manage with legal categories must remain outside of the legal world, because everything that is not legally controllable and rationally justifiable/explainable is likely to make us slide down the slippery slope that leads to the abyss of ordeal rites; which would nullify all the progress made by the “law of evidence” over the centuries, both in civil and criminal matters. In criminal proceedings, for example, the law of evidence has moved from trial by ordeal (*lato sensu* mythological evidence) to legal evidence (legal tariffs), then to inner conviction (where heart and reason combine, in the secret chamber of the human soul) and, finally, to free conviction (supported by legal and rational grounds of the decision): in a path of refinement of the rationality of the judgment (aimed at determining whether or not the guilt of the defendant has been proved beyond reasonable doubt) and of its justification (explanation / grounds of the decision).

¹² On this point, *ex plurimis*: AA. VV., *Judicial Decision and Scientific Truth*, Milan, 2005; L. DE CATALDO NEUBURGER (ed.), *“The Decisional Operation” from Divine Emanation to Scientific Evidence. Passing through Rabelais*, Padova, 2014; L. DE CATALDO NEUBURGER (ed.), *Scientific Evidence in Criminal Trial*, Padova, 2007; AA.VV., *Scientific Evidence in Criminal Trial*, in *Dir. pen. proc. – Dossier*, 2008; G. CARLIZZI, G. TUZET (eds.), *Scientific Evidence in Criminal Trial*, Turin, 2018; R. BORSARI (ed.), *Science submitted to Trial*, Padova, 2016; G. CANZIO, L. LUPÁRIA (ed.), *Scientific Evidence and Criminal Trial*, Milan, 2018; M. BERTOLINO, G. UBERTIS (eds.), *Scientific Evidence, Evidentiary Reasoning and Judicial Decision-Making*, Naples, 2015; A. AMATO, G. FLORA, C. VALBONESI (eds.), *Science, Law and Criminal Trial in the Age of Risk*, Turin, 2019; C. CONTI (ed.), *Science and Criminal Trial. New Frontiers and Old Prejudices*, Milan, 2011; F. CAPRIOLI, *Science “bad teacher”: the Pitfalls of Scientific Evidence in Criminal Trial*, in *Cass. pen.*, 2008, 3520 ff.; G. CARLIZZI, *Judge 2.0. and the Use of Specialized Knowledge in Criminal Trial*, in *Proc. pen. giust.*, 2017, 732 ff.; G. CARLIZZI, *The Evaluation of Scientific Evidence*, Milano, 2019; C. CONTI, *Evolution of Science and the Role of the Experts in the Criminal Trial*, in S. CANESTRARI, F. GIUNTA, T. PADOVANI (eds.), *Medicine and Criminal Law*, Pisa, 2009, 335 ff.; C. CONTI, *Scientific Evidence*, in P. FERRUA, E. MARZADURI, G. SPANGHER (eds.), *Criminal Evidence*, Turin, 2013, 87 ff.; O. DOMINIONI, *The Italian Experience about the Use of Scientific Evidence in Criminal Proceedings*, in *Dir. pen. proc.*, 2015, 601 ff.; O. DOMINIONI, *Scientific Evidence (Crim. Proc.)*, in *Enc. dir.*, II, Milan, 2008, 976 ff.; G. GENNARI, *New and Old Forensic Sciences at the Test of the Courts. An International Comparison ad a Proposal for the Future*, Santarcangelo di Romagna, 2016; P. RIVELLO, *The Need to Prevent Junk Science from Entering the Courtrooms: Rethinking About some Recurring Claims*, in www.penalecontemporaneo.it, November 8, 2017; P. TONINI, *The Supreme Court upholds Daubert Criteria on Scientific Evidence. Reflections on the verification about the maxims of experience*, in *Dir. pen. proc.*, 2011, 1341 ff.; G. UBERTIS, *Scientific Evidence and Criminal Justice*, in *Riv. it. dir. proc. pen.*, 2016, 1192 ff.



sonable doubt \neq more probable than not), the reasoning technique used to approach science in the various legal fields can well be the same.¹³

4. How Judges (should) Deal with Scientific Evidence and Scientific Hypotheses. Reinforced Reasoning on Science

In order to manage scientific knowledge and translate it into legal language, it is in any case necessary to ‘understand and retain’¹⁴ such knowledge; although the specific content of the technical information remains outside and alien to the non-expert’s field of investigation.

For example, if the expert discloses the calculation method used to obtain a certain result and explains why that method was used, rather than another, then the jurist – who, in addition, may further examine the matter and discuss it with other scientists – is able to appreciate the reliability of that scientific reconstruction, despite remaining incapable of performing the technical operation under discussion.

Let’s make a simple (and limited) comparison. Let’s take a soccer match. If we know the rules and tactics of this sport, even if we cannot even kick a ball, and without being on the field, we can understand if the players are playing according to the rules, if they are arranged in a certain tactical formation, if the goals scored are valid or not, etc. Although many subtleties of the game may evade us, at the end of the match we will know if team A or team B won, or if the two teams drew, and we will even be able to say who played better, even if only by referring to the respect of the rules and tactics of this sport that we know. Well, starting from the common knowledge of the game rules and tactics, those who do not know – or better, know only this – about soccer can communicate with those who *do* know and live soccer every day.

This, indeed, is just part of our everyday experience: what makes human communication possible is a common basic language (verbal and non-verbal) that we all share.

In the relationship between science and law, the scientific method acts as the common and shared basic language, used by the scientist and the jurist to communicate. The judge’s role is, as authoritative literature put it, “that of a *gatekeeper* of the scientific nature of the evidence, through the control of the method used to form that evidence, in view of properly stating the reasons for the decision. [...] This is a fundamental step: the difficulty of handling the merits of ‘other’ knowledge, such

¹³ Therefore, the method of judgment and the justification (grounds / statement of reasons) of the decision concerning the scientific evidence – which can be summarized as ‘reinforced reasoning on science’ and will be discussed below (par. 3.) – may be applied, insofar as compatible, to all branches of the legal system: as a general doctrine of law.

¹⁴ The expressions, re-adapted to the context of course, are taken from A. DANTE, (*Divine*) *Comedy*, Paradise, V, 41-42: “For having heard [understood] without retaining doth not knowledge make” (translated by C. Langdon). In addition to the contextual readjustment, it is important to point out that the verb ‘retain’ – which in the passage quoted from the *Comedy* means ‘keep in mind, remember’ – should also be intended as [in the Italian other meaning of *ritenere*] “have a certain personal opinion about something or someone, consider”. On the other hand, both ‘(hearing and) understanding’ a concept – that is, making it one’s own through perceiving and learning – and memorizing it presuppose a more or less active and conscious participation of the person who intends/understands and memorizes (*recte* retains/holds).

as scientific knowledge, has led to focus on method, in an attempt to reach that line where the *method* and the *merits* of the theory end up meeting”.¹⁵

At this point, we have both the place of reference (*i.e.*, the legal proceedings and the relevant rules) and the subject to be discussed using the common language (*i.e.*, the scientific method) to go back to that initial question: ‘how does (should) the judge evaluate scientific evidence?’.

We have said that the judge must focus on the method: but what exactly does ‘focus on the method’ mean?

As far as new or controversial scientific theories are involved, courts have devised a scheme – which gives rise to an operative method to be followed, consisting in a grid of questions to be answered – in order to distinguish ‘good’ from ‘bad’ science. We refer to the so-called Daubert test¹⁶, as implemented and refined by the Italian Supreme Court in various judgments: Cozzini, Cantore, Sartori, Knox-Sollecito, Bordogna, Cappel, Pesenti, Cirocco, Beduschi, Palleschi, Bossetti, De Santis, Spallanzani, etc.¹⁷

In particular, to avoid the risk of using the so-called *junk science* as a basis for the decision and to establish whether the science involved is scientifically reliable (on the basis of the best knowledge available at the time of the proceedings), the judge will have to examine the new or controversial scientific theory put forward by the expert, at least in the light of i) its diffusion (*e.g.* publication in accredited scientific journals; peer review) and acceptance by experts (consensus), ii) the knowledge of its rate of error, iii) its submission to counterexamples (falsifiability) and its controllability/testability (*i.e.*, its being reproducible – obtaining the same results – in the laboratory), (iv) the source from which it comes (*e.g.* the expert’s curriculum vitae, integrity and reputation), and v) its

¹⁵ C. CONTI, *BARD as Paradigm of Method: Legalizing Judicial Conviction without Arithmetic Reductionism*, in *Dir. pen. proc.*, 2020, 834. We highlight that Conti is the first to apply the expression ‘reinforced reasoning’ with reference to scientific evidence (both here [833] and elsewhere [C. CONTI, C. ROSSI, *Experimental Methods and Reinforced Reasoning: The Processualist Interrogates the Scientist*, in A. NATALINI (ed.), *Agri-food Frauds: Legal Profiles and Protection Perspectives*, Milan, 2018, 191; C. CONTI, *Controversial Science and Criminal Trial: The Supreme Court and ‘Discourse on the Method’*, in *Dir. pen. proc.*, 2019, 848 ff.]). For a general study on the institute of reinforced reasoning, see M. CECCHI, *Reinforced Reasoning of the Decision. A new Logic-Argumentative Model of Stilus Curiae*, Milan, 2021.

¹⁶Actually, it is more accurate to speak of the ‘Daubert-Joiner-Kumho trilogy’ (Daubert v. Merrel Dow Pharmaceuticals, Inc., 509 U.S. 579, 113 S. Ct. 2786 [1993]; General Electric Co. v. Joiner, 522 U.S. 136, 146 [1997]; Kumho Tire Co., Ltd. v. Carmichael, 526 U.S. 137 [1999]). With these three judgments, the so-called Frye test (Frye v. United States, 293 F. 1013, D.C. Circ. 1923, a judgment according to which the scientific validity of a theory rests predominantly – or we might say, in practice, exclusively – on the consensus of the community of experts: criterion of accreditation) is developed and expanded.

¹⁷ On this point, see C. CONTI, *Controversial Science and Criminal Trial*, cit., 848 ff. The details of the judgments cited are the following: Crim. Cass., Sec. IV, September 17, 2010, no. 43786, Cozzini, in *CED Cass.* no. 248943; Crim. Cass., Sec. IV, January 29, 2013, no. 16237, Cantore, in *Giust. pen.*, 2013, 695; Crim. Cass., Sec. IV, February 13, 2015, no. 8527, Sartori, in *CED Cass.* no. 263435; Crim. Cass., Sec. V, March 25, 2015, no. 36080, Knox-Sollecito, cit.; Crim. Cass., Sec. IV, November 3, 2016, no. 12175, Bordogna, in *CED Cass.* no. 270385; Crim. Cass., Sec. IV, October 3, 2017, no. 1886, Cappel, in *CED Cass.* no. 271943; Crim. Cass., Sec. IV, November 10, 2017, no. 55005, Pesenti, in *CED Cass.* no. 271718; Crim. Cass., Sec. IV, April 16, 2018, no. 16715, Cirocco, in *CED Cass.* no. 273096; Crim. Cass., Sec. IV, May 15, 2018, no. 46392, Beduschi, in *CED Cass.* no. 274272; Crim. Cass., Sec. I, May 18, 2018, no. 11897, Palleschi, in *CED Cass.* no. 276170; Crim. Cass., Sec. I, Oct. 12, 2018, no. 52872, Bossetti, in *CED Cass.* no. 275058-04; Crim. Cass., Sec. IV, Nov. 16, 2018, no. 412, De Santis, in *CED Cass.* no. 274831; Crim. Cass., Sec. IV, June 13, 2019, no. 45935, Spallanzani, in *Sist. pen.*, February 13, 2020.



value as evidence in relation to the facts to be ascertained. These are the salient and decisive – *but not exclusive* – points that, when checking the scientific validity of new or controversial scientific evidence, the judge cannot fail to consider.

The criteria, both objective (*e.g.* the rate of error) and subjective (*e.g.* the integrity of the expert and of the research carried out), on which this model of ‘interrogation of science’¹⁸ is based, are by no means exhaustive. On the contrary, they represent a *minimum*, which can be expanded depending on the specificities of the branch of knowledge under examination. Moreover, these questions – and the arguments underlying them – do not exclude, but rather prompt an in-depth investigation of further issues and arguments.

Therefore, whilst this model is certainly and primarily valid to evaluate the quality of new or controversial science¹⁹, it is nevertheless easily extended – especially if we add other questions, gauged to the peculiarities of the subjects to be analyzed – to the evaluation of science *tout court*.

Ultimately, what is important is this particular *modus operandi*. In the trial, the judge’s line of reasoning is developed by sifting through scientific knowledge that has been formed and consolidated – or is slowly consolidating – elsewhere. This is materially possible thanks to the experts, whose help is subsequently verified – in terms of reliability (*i.e.* competence, impartiality and validity) – and tested in a sort of cross-examination among the experts themselves.

The reasons and counter-reasons circulating around that scientific law allow the judge to establish, *ex ante* and in the abstract, whether that law is reliable or not (*e.g.* because it is supported by contradictory studies; because there are still relevant unexplored aspects; because there are traditional and viable alternative techniques that lead to the same result; etc.).²⁰ When the specialist knowledge is considered to be reliable enough to be used, the judge then has to verify that it corresponds to reality. On the basis of legitimately acquired evidence, the judge must trace the signs of the actual form that such knowledge takes in the circumstances²¹ to then draw the conclusions, by combining the

¹⁸ Referring to Cozzini judgment, D. PULITANÒ, *Populism and Criminal. On the Current Spiritual State of Criminal Justice*, in *Criminalia*, 2013, 141 speaks of “rigorous path of interrogation of science”.

¹⁹ Applies the so-called Daubert test to neuroscience testing, for example, L. ALGERI, *Neuroscientific Evidence in Criminal Trial*, Padova, 2020, 202-206. And a similar proposal concerning AI and algorithm tools is supported by, for example, F. C. LA VATTIATA, *Criminal Liability for damages caused by AI at the Process Test*, in R. GIORDANO, A. PANZAROLA, A. POLICE, S. PREZIOSI, M. PROTO (eds.), *Law in the Digital Era. Person, Market, Administration, Justice*, Milano, 2022, 708 (see 699/707-709); V. MANES, *The Algorithmic Oracle and Criminal Justice: at the Crossroads between Technology and Technocracy*, in *discrimen*, May 15, 2020, 21; A. M. MAUGERI, *The Use of Predictive Algorithms to ascertain Social Dangerousness. A Challenge between Evidence Based Practices and Protection of Fundamental Rights*, in *Arch. pen.*, 2021, 20 and nt. 78-79, as well as 23-27; E. NAGNI, *AI, the Innovative Relationship of (in)compatibility between Machina Sapiens and Criminal Proceedings*, in *Sist. pen.*, 2021, 7, 28-30; S. QUATTROCOLO, *Something better than Criminal Law (and Criminal Process)*, in *discrimen*, June 26, 2020, 8.

²⁰ In common law systems, this scrutiny only takes place only at the moment of admission of specialist evidence (to avoid the risk that the jury may take their decision under the irredeemable influence of junk science, and without stating the reasons for such decision); in civil law systems, it can also be extended beyond the moment when scientific evidence enters the proceedings, to include the subsequent evidence assessment, which must be reasonably explained.

²¹ In the context of the trial, the signs of the form taken in practice by a scientific theory are found by noting that the evidentiary element α is equivalent to the event or phenomenon of reality β . For example: from the traces of bullets on the wall, according to the ballistic reconstruction carried out using the γ method, it can be deduced that the shot was fired from the type of weapon δ .

scientific interpretation *de qua* with and within the logical-juridical argumentation of the case at hand; finally, the judge must duly state the grounds on which the decision is essentially based.

In this scenario, the judicial assessment of the (methodological) reliability of the science intersects in perfect symmetry with a method of judgment (evaluation) and justification (explanation / grounds of the decision), developed by case law and refined by specialist literature, which breaks down the reasoning behind the judgment into several necessary logical steps: that is, the duty of reinforced reasoning.

By ‘reinforced reasoning’ we mean “a formula which, on the one hand, advises caution with regard to certain specific legal profiles related to the decision-making process and, on the other hand, demands that the decision be based on more solid grounds with regard to such questions (*recte* arguments), the verification of which is considered essential for the legitimacy of the measure issued. [...] The peculiar characteristic of this method of judgment (*i.e.* evaluation) and justification (*i.e.* reasoned explanation of the reasons for the decision) lies in the fact that the judge is required to go through a series of necessary steps, made up of arguments concerning salient aspects of the case under examination and which must be appreciated (*i.e.* adapted in content to the specifics of the concrete case) in the light of parameters and criteria that are widely shared and/or consolidated, as well as inter-subjectively verifiable”.²²

In the case of ‘reinforced reasoning on science’, the arguments – oriented by shared and/or consolidated parameters and criteria, and inter-subjectively verifiable – to be necessarily appreciated are those useful to probe the reliability of the new or controversial science, which – as mentioned above – can and indeed must be extended and developed in relation to the specifics of the branch of knowledge under consideration.

True, in such a ‘procedural management of science’, the balance of the various parameters of scientificity to be evaluated remains an open issue²³; but the reliability of a theory, and its applicability in the circumstances, can only be determined *case by case*.

5. An Example. About an Innovative DNA Panel associated with New Technology named Next Generation Sequencing

Now, let’s try to transfer our theoretical considerations to practice, by applying the prototype of reinforced reasoning on science to an innovative DNA panel, developed by Forensic Molecular Anthropology Unit of Department of Biology – University of Florence, associated with new technology (called Next Generation Sequencing).²⁴

The idea of developing a new specific DNA panel to infer kinship relationship stems from the desire to also distinguish distant relationships from unrelatedness. As expected, and proposed in a recent

²² M. CECCHI, *Reinforced Reasoning*, cit., 437.

²³ C. CONTI, *Scientific Evidence on the Threshold of Twenty Years since the Franzese judgment: Peaks and Dizziness in the Age of Pandemics*, in www.sistemapenale.it, February 9, 2021.

²⁴ As anticipated at the beginning of this Special Issue (see above: E. PILLI, M. RIZZUTI, *Introduction*), the scientific theory/thesis we refer – which, in legal terms, represents a new or controversial scientific evidence – is the result of the project *Missing persons and new technologies between forensic anthropology and private law*, whose we anticipate – only in part and only for what is of our interest, here – the results.

paper,²⁵ the power for identifying the *true* relationship decays in the order of autosomal sharing: parent-child and full siblings can be robustly identified against other relationships but for half-siblings the chance of reaching a significant conclusion is already small and for more distant relationships the proportion of cases correctly and significantly identified is 10% or less. In this way, the scope of the forensic kinship analysis could be extended from simple parentage cases to more distant or complex relationships, such as unknown human remains of disaster/war victims, or missing persons.

With the contribution of the expert, we will simulate an *interrogation of science*. The jurist asks the scientist some of the main questions through which (*i.e.* by dealing with and answering to which) the judge fulfills the duty of scientific reinforced reasoning. The answers to the questions – *recte* to the arguments raised by the questions – are sketchy and merely hypothetical, as they have merely illustrative value.

Let us begin.

1) Why would this DNA panel associated with new technologies represent a progress of current science – as opposed to a pseudoscience? Is this a scientific theory being tested/validated? If so, what stage of consolidation is it at? Are there publications in scientific journals that support it?

It represents a progress of current science because actual technologies and panels let you know only first-degree kinship relations (father-son, mother-son; in truth, even second-degree relations in case of full siblings [not adopted], but): only this. With this DNA panel associated with Next Generation Sequencing technology, it is also possible to distinguish family relationships that are more distant than those of the first-degree. Anyway, this innovative theory is not yet officially validated. There are pending publications concerning the panel adopted: that is the innovative part of this technique/theory.

2) Is there a traditional science or technique that is already used to solve the same problems as this innovative technique?

No. As we said, the current technology allows us to identify – with (relative) certainty – only first-degree relationships, but it does not go beyond (except for the hypothesis of blood brothers). In this way, traditional science is not used to solve the same problems.

3) Are there any scientific interpretations that are totally in conflict with your theory? If so, why would your scientific theory offer better results, despite the criticism? Has your theory ever been subjected to falsification attempts?

No; not at this time. About falsification, yes: we are testing (also falsifying) this new scientific technique in the validation phase.

4) In which laboratories has your thesis been (and is being) tested? Are the experiments repeatable with the same results?

²⁵ E. PILLI, R. TARALLO, P. L. RICCIA, A. BERTI, A. NOVELLETTA, *Kinship assignment with the ForenSeq™ DNA Signature Prep Kit: Sources of error in simulated and real cases*, in *Science and Justice*, 2022, 621, 1.

Yes, of course the experiments are repeatable; and the results produced turn out to be the same, every time (so far). Our thesis is tested in laboratories of the University of Florence and in other certified laboratories.

5) What are the main critical aspects of your scientific theory? What is, for example, its error rate? Is it possible that in the present case, based on the available evidence, one of these adverse events occurred?

Our theory is still being validated and for this reason we don't know exactly its error rate. At the moment, by the way, we don't see criticalities; and we don't see criticalities also because the assumption on which the theory is based is the indisputable consideration that "I am more similar to those who are more related to me than those who are not". For example, obviously I am more similar to my grandfather than to my friend (unrelated).

6) By whom was (or is, as the case may be) your research funded? Can there be any co-interest such as to cast doubt on the impartiality of the entire study?

We won a public call, based on a research project we submitted. There are no co-interests, neither of public nor of private nature, in our research activity.

7) Who developed the theory that underlies this innovative DNA panel associated with new technologies? What is the qualification of this expert and of the other experts that support it?

The theory that underlies this innovative DNA panel associated with new technologies was developed by professors, researchers, and PhDs, as well as experts and practitioners in the field (whose contribution has been fundamental in bringing the theory to life).

As we said, the answers to the questions – *recte* to the arguments raised by the questions – are sketchy and merely hypothetical, as they have merely illustrative value. Many other questions could be imagined (*e.g.* Can you summarize, step by step, the various operations that you have carried out and the reference parameters to which you have adhered in carrying out the analysis?; In relation to the present case, are there other alternative traditional methods to resort to, and through which the same result can be obtained?; What is the purpose/aim of this research? Have these studies been commissioned by any public or private entities? If so, which ones?; etc. etc.); but, above all, it is the content filling of the questions, related to the specific juridical case, that is the essential aspect. In this simulation we have not referred to particular historical episodes, however it is precisely with the concretization case by case of the individual argumentative questions that we can appreciate how the quality of the judgement is enriched by this method of legal application of science to the single case.