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IN DEFENCE OF SUBJECTIVITY: EXTENDING THE ARGUMENT FOR A TRANSPARENT TRIAL. (A SUPPORT ON "BAYESIAN MODELLING OF CRIMINAL CASES AS A WHOLE. A PHILOSOPHICAL REFLECTION ON DUTCH CASE LAW")

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ABSTRACT: This comment addresses the "prior challenge" in forensic Bayesian modelling, recently highlighted by Anne Ruth Mackor (2026). We argue that the perceived lack of frequency data is not an insurmountable obstacle but a misconception rooted in an outdated view of probability. By adopting a radical subjectivist perspective based on de Finetti's teachings, we reframe probability as a coherent representation of a decision-maker's state of knowledge. We advocate for a strict functional separation: forensic experts provide the likelihood ratio based on technical findings, while the court assigns prior odds based on the specific case context. Through sensitivity analysis, we demonstrate that the subjectivity of priors can be viewed not as a source of arbitrariness but rather as a transparent and auditable mechanism that enhances judicial accountability. Ultimately, the Bayesian model is presented as a logical necessity for preventing miscarriages of justice.

Keywords: bayesian modelling; forensic science; subjective probability.

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1. INTRODUCTION: REFRAMING THE CHALLENGE OF THE CHOICE OF PRIORS

The application of Bayesian networks and probabilistic modelling to entire criminal cases represents one of the most significant shifts in contemporary legal epistemology. In her comprehensive reflection on Dutch case law, Anne Ruth Mackor (2026) provides a crucial map of this territory, exploring whether the Bayesian model can truly provide guidance for the judicial evaluation of evidence and interpretation of cases; an aspect already extensively discussed more than forty years ago (see, e.g. Eggleston, 1983; Lempert, 1977; Tillers, 1986; Tillers and Green, 1988; Kaye, 1988). While acknowledging its power as a rational method (Mackor, 2026 at p. 1), Mackor identifies a recurring friction point that often halts the model's adoption: the assignment of prior probabilities.

As Mackor correctly points out, the transition from forensic laboratories, where the likelihood ratio (LR for short) measure is the standard output, to the courtroom is hindered by the lack of relevant data. She notes that in criminal law, there are usually no reliable statistics about the frequencies of the events that are relevant to determine the prior odds and, consequently, such assignments must often be a matter of subjective estimation (Mackor, 2026 at p. 4)[1]. For many legal and scientific scholars and practitioners, this subjectivity is viewed with suspicion, as if it introduced an arbitrary element into an otherwise rigorous scientific process.

The purpose of this comment is to challenge the notion that subjective assignment is a weakness of the Bayesian system. We argue that the so-called "prior challenge" is essentially a non-problem if one adopts a radical subjectivist perspective

[1] Note that the term "estimation" can be misleading. As discussed by Fischhoff and Beyth-Marom (1983), 'The term "assign" is used rather than "estimate" to emphasize that a probability expresses one's own feelings rather than an appraisal of a property of the physical world. Thus, there is no "right" probability value for a particular statement' (at p. 240).

rooted in the teachings of Bruno de Finetti (de Finetti, 1968, 1972) and Dennis Lindley (Lindley, 1991). Subjectivity, in this sense, is not a synonym for arbitrariness, but rather a transparent quantification of a decision-maker's state of knowledge.

It is important to note that while Mackor (2026) rightly emphasizes the role of Bayesian networks in legal fact-finding, the present comment does not delve into their structural implementation. We fully acknowledge that Bayesian networks represent the most robust and coherent framework for evaluating complex patterns of evidence and their inferential interactions, a field where we have contributed extensively in our own previous work (e.g., Aitken and Gammerman, 1989; Taroni *et al*., 2014) following the teaching of David Schum and Jay Kadane (Schum, 1994; Kadane and Schum, 1996). However, the focus of this paper is not on the architecture of evidence evaluation, but on the epistemological hurdle that precedes it: the prior challenge. By addressing the nature of subjective probability and the division of labour between the expert and the judge, we aim to clear the ground, ensuring that the powerful tools offered by Bayesian networks are built upon a firm and transparent logical foundation.

The present article is organized as follows. After this introduction, Section 2 provides a foundational definition of subjective probability, clarifying that it represents a state of knowledge rather than a physical property of the world, and illustrating how it can be rigorously quantified. Section 3 addresses the ontological nature of probability, arguing that the lack of frequency-based statistics does not preclude the formulation of coherent prior odds. Section 4 explores the division of labour between the forensic expert and the judge, responding to Mackor's queries regarding *who* should use the model (Mackor, 2026 at p. 11) by emphasizing that the prior odds is the exclusive and necessary domain of the court. Section 5 addresses common critiques regarding the subjectivity of priors by employing sensitivity analysis; this demonstrates that the Bayesian framework remains robust even in the absence of precisely defined prior distributions. Finally, Section 6 warns against the dangers of attempting to evaluate evidence in what may be thought of as a contextual vacuum, concluding that the Bayesian model is not just an option, but a logical necessity for preventing miscarriages of justice.

2 WHAT IS SUBJECTIVE PROBABILITY? A BRIEF CLARIFICATION

To understand why the prior challenge is a manageable hurdle, one must first clarify the nature of probability itself. As it has been argued extensively in philosophical and statistical literature (e.g. de Finetti, 1974), there is a persistent misconception in legal scholarship that for a probability to be so-called "reliable", it must be "objective" (in some sense), meaning it must be derived from long-run frequencies or hard statistical data.

2.1. Probability as a state of knowledge

Following the radical subjectivist tradition of Bruno de Finetti, we maintain that probability is not an external, physical property of the world (like mass or length), but a representation of an individual's degree of belief in the occurrence of an event, given the information available at that time. In this sense, all probabilities are conditional: they depend on the state of knowledge (at a given time) of the person making the assessment.

For a judge, this is not a revolutionary concept; it is the formalization of what legal systems call "free evaluation of evidence". When a judge assesses a case, they are updating their personal state of uncertainty based on the evidence presented.

2.2. The role of frequencies

A common critique is that subjective probability ignores what is called "hard data". On the contrary, the subjectivist framework perfectly reconciles personal beliefs with frequencies (Lindley, 1991). As shown in numerous works on de Finetti's Representation Theorem and exchangeability (see, e.g., Dawid and Galavotti, 2009; Taroni *et al*., 2018), frequencies are simply a specific type of information that a rational agent uses to update their beliefs.

Data does not speak for itself; it requires a subject to interpret its relevance to the specific, unique case at hand. Therefore, subjectivity is not a source of error, but the necessary mechanism through which evidence is given meaning (Press and Tanur, 2001). By naming it *subjective*, we are not admitting to a lack of rigor, we are providing a transparent account of the reasoning process, making it auditable and logically coherent.

2.3. How to quantify subjective beliefs: the logic of comparison

A frequent objection is: 'How can a judge assign a precise number to a subjective belief?' The answer lies not in a guess, but in a process of logical comparison (Biedermann *et al*., 2013, 2016). As many quarters have discussed in scientific and legal literature (see, e.g., Lindley, 1975), quantifying a subjective probability means expressing a preference between different uncertain outcomes.

A common method is the reference experiment (or the betting analogy): if a judge says the probability of a hypothesis is 10%, they are saying they find that hypothesis as likely as drawing a red ball from an urn containing 10 red balls and 90 white ones. This mental exercise forces the decision-maker to calibrate their internal uncertainty against a known external standard.

For sake of illustration, consider the "prior" in a burglary where a DNA trace is found. Before looking at the DNA result, the judge must assess the "prior" probability that the suspect is the source.

— If the suspect was found 500 metres from the scene shortly after the crime with no alibi, the judge might reasonably assign a numerical value to their degree of belief (e.g., 1/100) based on the pool of potential people in that area at that time.

— If the suspect was instead identified only via a national database search with no other link to the city, the prior would be much lower (e.g., one over the size of some relevant population, where relevance has to be determined with reference to other information surrounding the case).

The number is not arbitrary because it must be coherent with the available background information. If the judge's assessment is transparently stated, it can be debated and challenged by the parties. Subjectivity thus becomes an instrument of precision: it allows the court to distinguish between a vague suspicion and a grounded hypothesis using the universal language of logic.

3 THE ONTOLOGICAL STATUS OF PROBABILITY AND THE MYTH OF "OBJECTIVE" DATA

In her analysis, Mackor (2026) identifies a fundamental hurdle for the legal application of Bayesian networks: the perceived lack of reliable statistics to determine prior odds. She notes that, in the absence of such data, the assignment of probabilities becomes a matter of subjective estimation, which may lead to a lack of intersubjective agreement among the actors in the trial. This challenge highlights a widespread epistemological friction in the forensic field: a lingering frequentist-like expectation that probability should ideally be an objective property of the world, measurable only through repeated trials. From this common viewpoint, which often conflates "subjective" with "arbitrary", subjectivity is seen as a fallback to be used only when so-called hard data are missing.

However, as we have argued in a previous publication (Taroni *et al.*, 2018), this objection stems from a misunderstanding of the nature of probability itself. Following the subjectivism of Bruno de Finetti, we maintain that "Probability does not exist" (de Finetti, 1974) as an external, physical entity[2]. Instead, probability is a formal expression of a subject's degree of belief based on the information available. Far from being a sign of arbitrariness, the subjectivist approach simply provides a formal, transparent structure to the reasoning processes that judges already exercise daily. By

[2] As Bruno de Finetti (1974) provocatively stated in his seminal essay, the concept of probability is not an objective property of the physical world, but a formal expression of a subject's state of knowledge. For the legal evaluator, this shift is crucial: it moves the focus from the search for an elusive "objective frequency" to the construction of a coherent and transparent belief system based on available information.

explicitly quantifying uncertainty, the judge shifts from an opaque, unchallengeable "gut feeling" to clear lines of reasoning.

To clarify this point, let us consider two examples that illustrate why what is believed to be "objective" statistics are, in fact, always filtered through subjectivity:

1) The DNA database example: consider the occurrence of a genetic profile (e.g., 1 in a million) derived from a database. This number is a relative frequency, a historical record of past observations. To use this as a probability for the case at hand, the evaluator must assume that the database population is one of which the defendant could be considered a member. If the defendant (and the real donor of the recovered stain) belongs to a specific ethnic subgroup not represented in the database, the statistic becomes irrelevant. The choice to use that 1-in-a-million figure is, therefore, a subjective judgment based on the assumption of symmetry.

2) The local crime rate example: if a judge knows that 80% of burglaries in a specific district are committed by local residents, this 0.8 frequency does not automatically become the prior probability for a new suspect. The judge must decide if the statistic (80%) about burglaries in a specific district are committed by local residents is relevant for the specific circumstances of the current arrest (e.g., the suspect was caught at a train station). Without this subjective leap, the figure 80% is irrelevant.

Analogously, see also Lindley (2014 at p. 150): 'The records of the doctor observing the presence or absence of a symptom with a disease, you might think exchangeable,[3] though if you knew the sexes of the patients and thought the disease was sex-related, you might not. This example also serves to illustrate an important point, that since the definition of exchangeable depends on your probabilities, it depends on your knowledge base, and a series exchangeable under one base, without knowledge of sex, may fail to be under another, with knowledge of sex.'

As we would like to express, the subjectivist framework does not ignore empirical data; it provides the only coherent way to integrate them through the Representation Theorem (de Finetti, 1982; Dawid, 2004). Frequency data are simply observations of past events. For these observations to inform a current, unique case, a judge must assume a degree of symmetry (or exchangeability) between those past events and the case at hand.

As Kadane (1995) has argued, the requirement for a prior probability is not that it be objectively true, but that it be coherent. By requiring the judge to assign a prior probability, the Bayesian framework forces an unprecedented level of transparency. It compels the court to state its initial assumptions clearly, rather than leaving them buried in the black box of unquantified judicial intuition. In this sense, the subjec-

[3] "Exchangeable" in the sense that the order in which the records are considered is not relevant to any inference which may be made from them. Exchange the order of consideration and the inference remains the same. If there is knowledge of sex this may not be the case.

tive "estimation" Mackor (2026) refers to is actually a safeguard: it transforms hidden biases into explicit and testable situations. The subjectivist approach offers a coherent language and tool set for handling uncertainty.

4 DEFINING THE BOUNDARIES (TO EACH ONE THEIR OWN PROBLEM)

A central question raised by Mackor (2026) concerns the practical implementation of the Bayesian perspective: should non-forensic experts and judges engage directly with probabilistic reasoning? She notes that while the Netherlands Forensic Institute (NFI) provides likelihood ratios as a coherent metric to assess the value of scientific findings, the integration of these results into a broader criminal case remains a challenge for the judiciary (at p. 12). From our perspective, this difficulty does not stem from the complexity of the Bayesian approach itself, but from a persistent lack of clarity regarding the division of labour between the expert and the trier of fact. The most effective way to address the so-called "prior challenge" is to adhere to a strict functional separation: to each one their own problem to solve!

Guidance in the use of Bayes nets for judges, lawyers, forensic scientists and expert witnesses is given in the third of four guides on *Communicating and Interpreting Statistical Evidence in the Administration of Criminal Justice* published by the Royal Statistical Society (Roberts and Aitken, 2014). There it is noted that "Bayesian networks assist their users … to understand the structure of complex inferential problems, to form a better appreciation of mutual dependencies between uncertain events and compound probabilities, and to express this understanding in a graphical form that both assists in deepening their own comprehension and enables them to communicate their insights to others. Bayes nets help to clarify the nature of arguments predicated on probabilistic argument and thus promote logical analysis and rational further discussion and evaluation of factual propositions".

Bayes nets provide an answer to both parts of Mackor's second question. They can be used by (a) an expert and (b) the court itself for "integral modelling of a case as a whole".

Bayes nets can be used in the investigative stage of a crime (Aitken *et al.*, 1996). Factors arising in the investigation can be incorporated into a graphical structure and their inter-relationships clarified visually. Similarly, a graphical structure can be used by advocates for assistance in summarising the case for the judge (e.g. Edwards, 1991). Then assumptions and probabilistic assignations can easily be checked by the judge for their reliability in assistance for the final decision about the outcome of the case.

4.1. The role of the expert: the likelihood ratio

The forensic scientist's responsibility is to evaluate the scientific findings (or the strength of the association observed between control and questioned materials) by comparing the probability of the findings under (at least) two competing hypotheses. This results in a metric called the likelihood ratio (ENFSI, 2015), which we consider a logical necessity rather than a mere professional convention. In this stage, the scientist must remain within the bounds of their technical expertise. This necessity arises from the requirement to maintain a coherent inferential process while respecting the functional separation between the expert's evaluation of evidence and the court's assessment of the case. They do not, and should not, provide the prior odds, as they do not have access to the full context of the case described by what is known as background information. If an expert were to incorporate prior probabilities into their report, they would be encroaching upon the judicial prerogative, effectively deciding the case rather than evaluating the findings (Biedermann *et al.*, 2007; Taroni and Biedermann, 2005).

The stricture that the scientist should not provide the prior odds does not mean the scientist cannot use a Bayesian network, with a node for the hypothesis of interest, to assist their evaluation of the evidence. The likelihood ratio is the ratio of the posterior odds in favour of a hypothesis to the prior odds. Thus, propagation of the evidence in a Bayes net will change the prior odds to posterior odds. The ratio of these two odds is the likelihood ratio. The value chosen for the prior odds cancels out with the posterior odds; increase the prior odds by a factor of 10, for example and the posterior odds will increase by a factor of 10 also, the likelihood ratio will be unchanged.

The professional guidelines for such reporting are clearly defined by the European Network of Forensic Science Institutes (ENFSI, 2015) and other scientific references (Berger, 2025), which mandate that forensic evaluations be presented as a measure of evidential strength rather than as a statement of guilt. Within this framework, the likelihood ratio is the most coherent measure for hypothesis confirmation, as demonstrated by philosophical and scientific literature (e.g. Taroni *et al.*, 2021). In addition, the likelihood ratio satisfies the necessary logical criteria for normative adequacy, offering a robust numerical expression for the impact of scientific findings on competing judicial hypotheses (Robertson *et al.*, 2016; Aitken *et al.*, 2021).

Unlike alternative, often informal, expressions of the value of evidence, the likelihood ratio provides a standardised, auditable metric that resists the logical pitfalls frequently encountered in courtrooms. By adhering to these rigorous reporting guidelines, the forensic scientist provides the court not with an opinion on the final outcome, but with a precise, logically sound tool to update their belief in light of the new scientific information (Thompson *et al.*, 2018).

It is essential to distinguish between the inferential stage, where we reason about the value of scientific findings and the decision-making stage, where the court must

decide on the ultimate issue, such as a defendant's guilt or innocence. Conflating these two stages is a primary source of logical incoherence. The Bayesian framework does not aim to automate the judge's decision, but to provide the necessary logical scaffolding to ensure that the transition from inference to decision is transparent. By formalizing one's degree of belief, we do not ignore uncertainty; rather, we provide a coherent language to manage it, ensuring that final decisions are not based on hidden intuition but on a structured, auditable reasoning process.

Entrusting the forensic scientist with the assignment of prior odds would effectively mean delegating the adjudication of the case to a laboratory. The expert's task is to provide the value of the evidence; the judge's task is to integrate this evidence into the broader context of the case. This separation of powers is the essential guarantee of a judicial system.

4.2. The role of the judge: the prior and the context

The judge (and in the adversarial system, a jury), on the other hand, is the only actor in the trial who possesses the integral view of the case. Therefore, the assignment of prior odds is the exclusive and necessary domain of the court. Mackor (2026) highlights difficulties in the determination as to how pieces of evidence should be combined (at p. 14-15, footnote 36). We argue that this difficulty is exacerbated when judges try to be seen to be objective by ignoring their own initial degrees of belief.

By using the odds form of Bayes' Theorem, the judge's role becomes clear: they take the likelihood ratio provided by the forensic expert and multiply it by their own prior odds, based on the context of the case, to arrive at the posterior odds. The context, or background information, of the case cannot be ignored. The Bayesian framework does not force a judge to become a statistician; rather, it provides a coherent language to ensure that the judge's integration of evidence is logically consistent.

4.3. Avoiding the contextual vacuum

The fear that judges are not ready for Bayesian modelling often leads to the dangerous practice of evaluating evidence in a vacuum. However, a piece of evidence has no meaning without a context; this is an established point dating back to Bertillon's 1886 and Locard's 1940 publications echoed by Robertson and Vignaux (1993). For instance, a DNA correspondence between genetic material associated with a crime scene and genetic material from a person of interest (offering a high value for the likelihood ratio if evidence is assessed under what are known as "source-level hypotheses") has different probative implications if the suspect was found near the crime scene (high prior) as opposed to cases where the suspect was identified through a random database search (low prior).

In conclusion, the Bayesian model is not an additional burden for the judge, but a tool for transparency. Its use clarifies the separation of the provision of the value of the evidence by the forensic scientist and the provision of the context by the judge. By separating these two components, the integrity of the trial is safeguarded from pitfalls of intuition (e.g. the prosecutor's fallacy) and it is ensured that the final inference and subsequent decision are a product of both scientific rigour and judicial responsibility.

5. ROBUSTNESS THROUGH SENSITIVITY ANALYSIS (FROM THEORY TO JUDICIAL PRACTICE)

A common anxiety among legal scholars is that different judges might assign different prior odds to the same case, leading to inconsistent or arbitrary outcomes. If the choice of prior is met with subjective assignment, how can the law ensure a degree of predictability and fairness? If the final decision remains unchanged despite a wide variation in the prior assumptions the verdict demonstrates a high level of robustness. This approach allows appellate courts to scrutinize the logical foundations of the decision, rather than second-guessing the hidden personal belief of the trier of fact.

5.1. The "Washing out" of the Prior

The focus of a rational trial should shift from *What is the exact prior?* to *Does the variation of the prior actually change the final decision?* At first, from a strictly subjectivist perspective, searching for an exact or true (prior) probability is a conceptual category mistake, as probability does not exist in nature but resides solely in the mind of the evaluator ("Probability is a state of mind not a state of nature" reported by Savage, 1972). Consequently, the task of the judge is not to estimate an objective frequency, but to assign a coherent value that transparently reflects their state of knowledge at a specific historical moment. Secondly, this approach relies on the principle that as the value of evidence (through its likelihood ratio value) increases, the influence of the prior odds on the posterior odds diminishes.

In many cases, the forensic evidence is so compelling (e.g., a high likelihood ratio value from DNA genotypes in paternity cases) that the posterior odds will point towards the same conclusion regardless of whether the initial prior was 1:2, 1:1,000 or 1:1,000,000. Through sensitivity analysis, we can demonstrate that the impact of the subjectivity of the judge is effectively "washed out" by the strength of the scientific findings (as long reported and proved in the statistical, judicial and forensic literature, see, e.g., Box and Tiao, 1973; Robertson *et al*. 2016). This provides a robust safeguard: the verdict is not just a consequence of the judge's initial bias, but a result of the evidence's dominance.

5.2. Transparency as a shield against arbitrariness

The true danger in legal fact-finding is not subjectivity itself, but *unstated* subjectivity. Judicial intuition is traditionally a black box that cannot be challenged. In contrast, an analysis of the effect of the choice of prior makes the judicial reasoning process auditable and transparent.

If a judge's conclusion is shown to be stable across a wide range of priors, the verdict gains a robustness that statistics based on frequency data can rarely provide in criminal cases which are generally unique by nature. This transparency allows for a more rigorous appellate review: the parties can debate the reasonableness of the prior range and the robustness of the evidence, rather than guessing the hidden thoughts of the trier of fact. Thus, analysis of the effect of the choice of prior transforms the prior challenge into an opportunity for greater judicial accountability.

6 THE DANGER OF THE CONTEXTUAL VACUUM AND THE PREVENTION OF MISCARRIAGES OF JUSTICE

In the final part of her article, Mackor (2026) reflects on the nature of Bayesian modelling as a tool for "Preventing miscarriages of justice" (The NWO research project, Mackor, 2026 at p. 20). While she expresses caution regarding the potential for misuse, we argue that the real danger to justice does not lie in the application of Bayesian reasoning, but in the absence of its application. Specifically, the greatest risk of error arises when evidence is evaluated in a contextual vacuum.

6.1. Context as a logical necessity

Evaluating evidence in a contextual vacuum is not merely a statistical limitation, it is a fundamental distortion of the legal truth. A piece of evidence does not possess an intrinsic meaning; its relevance is entirely dependent on the background information and the competing hypotheses. Moreover, facts in a courtroom do not exist in isolation, they are elements of a narrative. The Bayesian paradigm acts as a safeguard against this distortion, as it forces the decision-maker to formally acknowledge the impact of background information on the probability of the case hypotheses.

6.2. Misuse vs. invalidity

We must address the criticism that Bayesian ideas are inappropriate because it is very easy for them to be misused.The fact that a paradigm can be misused does not render the paradigm itself invalid. On the contrary, the Bayesian line of reasoning is

the only one that offers a coherent language and tool set to detect and correct such misuses. A model that makes its assumptions (priors) explicit is far easier to challenge and correct than a traditional holistic judgment where the reasoning remains hidden.

6.3. Bridging the gap: from data to justice

The reconciliation of subjective beliefs and frequency data is not just a statistical exercise, it is a requirement for fairness. A justice system that demands absolute objectivity where it cannot exist, such as in the unique circumstances of a criminal act, is a system that invites hidden biases. By embracing the subjectivist approach, the legal system moves toward a more honest form of rationality, where the uncertainty is quantified rather than ignored.

7. CONCLUSION: EMBRACING COHERENCE IN LEGAL FACT-FINDING

Anne Ruth Mackor's reflection on Dutch case law provides a timely opportunity to re-evaluate the role of Bayesian modelling in the courtroom. While the prior challenge is often cited as an insurmountable obstacle, we have demonstrated that this challenge is largely a product of an outdated frequentist view of probability.

By adopting a subjectivist perspective, we can conclude that:

1) Subjectivity is an asset, not a flaw, because it provides the necessary transparency for judicial reasoning.

2) The division of labour is key: forensic scientists evaluate the evidence through a coherent measure, the likelihood ratio, while judges provide the necessary context to assign the prior probabilities to the set of legally relevant hypotheses of interest to the court.

3) Robustness can be checked with sensitivity analysis. Such an analysis investigates how variations in prior specifications affect the outcome. This investigation ensures the legal process remains predictable and fair, even in the face of uncertainty. If the sensitivity analysis indicates a lack of robustness this casts doubt on the strength of the associated case.

The subjectivist approach does not make the inherent difficulties of criminal cases vanish, but it provides the only coherent framework for handling them. While we acknowledge that the debate on judicial objectivity is far from settled, we argue that a radical subjectivist approach offers a more logically consistent framework for the transparency of the trial. The Bayesian model is not merely a method to be added to the judge's toolkit, it is the logical foundation upon which a modern, transparent, and rational system of evidence evaluation and case interpretation must be built.

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