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Response paper

The consequences of understanding expert probability reporting as a decision☆

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ABSTRACT

In this paper we reiterate that the personalist interpretation of probability is inevitable and as least as informed as any other allegedly more 'objective' definition of probability. We also argue that the problem faced by forensic scientists, the reporting on imperfect personal knowledge, in terms of probabilities, can be reconstructed as a decision problem. Tackling this problem through a rigorous decision theoretic analysis provides further argument in support of the view that optimal probability reporting is in terms of single numbers, not intervals.

> "The calculus of probability can say absolutely nothing about reality; in the same way as reality, and all sciences concerned with it, can say nothing about the calculus of probability." [8, p. 215]

1. Introduction

So far in this collection of articles, we have argued along two main points.

First: Investigating controversial issues regarding the likelihood ratio requires an analysis of its components. These components are conditional probabilities (or, probability densities). It is for this reason that we have called our discourse 'a question of probability, not of likelihood ratio' [5].
Second: In essence, a probability expresses a reasoner's uncertainty about something – for example a state of nature of the past, present or future – that is not completely known to this person. For the purpose of the discussion here, it is also common to refer to uncertain quantities in terms of propositions (e.g., the proposition that the analytical features of a crime stain are of type Γ).

According to the above, a probability is one's expression of uncertainty about an unknown[1] quantity or state of nature, but one is not uncertain about one's probability. It is unsound, thus, for a person to make statements such as:

'I am unsure about the probability', or 'the probability is unknown (to me)'.

On that account, probability is not something that exists in the real-world that surrounds us, independently of an individual mind that contemplates about a particular aspect of the world. By extension, ratios of probabilities, too, do not exist, as noted in [3].

The measure of one's uncertainty about an unknown quantity or state of nature is a single number – a probability (yours, ours, anybodies) – for as different numbers, by definition, express different states of uncertainty. And, to emphasize this once again, the notion of uncertainty does *not* relate to the numerical probability that each and every person detains in their own way. Uncertainty relates to a proposition, the truth of which may be under dispute, and probability, in terms of a number, is the expression of an individual's personal state of uncertainty, about the proposition of interest.

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[1] It is important to emphasize that the imperfect knowledge intimately relates to the person who expresses a probability. It may well be that another person has a more elaborate knowledge base, or even complete knowledge about the particular state of nature or quantity of interest.

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Reporting a likelihood ratio as an interval would amount to reporting probability intervals for the numerator and the denominator: but is this the proper understanding of the notion of interval? Part of basic understanding is that probability is distributed over the various outcomes that an uncertain discrete quantity (e.g., the number of GSR particles) may take. In the same way, in presence of an uncertain continuous quantity (e.g., a population proportion θ), one may consider how much probability is assigned to particular ranges of possible values of the random quantity. For example, one may consider one's probability that an unknown population proportion θ lies between 0.6 and 0.8. So, there is an interval here, but it relates to the uncertain quantity θ, and *not* to the probability one specifies for the interval of values of θ. There is uncertainty about the proportion θ lying in the interval between 0.6 and 0.8. Probability expresses this uncertainty with a number, but here is no interval about this numerical probability. From this it follows that, since there is no interval (or, uncertainty) around a probability, there is also none for a ratio of two probabilities (i.e., the likelihood ratio).

Two aspects of the above starting point continue to raise discussion among some forensic scientists, as is demonstrated by position papers published so far in this Special Issue, but also in legal literature at large. The first aspect concerns the understanding that probability is an expression of personal belief[2] of an individual about something that is uncertain to this individual. Some commentators view this interpretation of probability skeptically and criticize it as being inappropriate. The second aspect concerns the understanding of probabilities, and hence likelihood ratios, being single numbers. Some quarters argue that this provides a poor descriptive account of how people intuitively perceive uncertainty and hence consider this to be a perspective difficult to adopt in practice. In this paper, we will discuss these two aspects in turn, and outline the reasons why we disagree with these skepticisms.

The paper is structured as follows. In Section 2, we will take a closer look at the notion of probability as personal degree of belief and discuss what this view of probability means and does not mean. We will insist on the point that the term 'personal' associated with the belief type interpretation of probability is not a synonym for arbitrary and speculation, and hence does not render personal probability inappropriate for forensic science. In Section 3, we will provide further argument – not raised so far in this Special Issue – in support of the view that probability is given by a single number. We will do this by introducing the notion of decision. Specifically, we will use decision theory as the overarching conceptual and analytical framework. Starting from only a few basic assumptions, we will engage in a defensible series of operations to derive all positions that we highlight in Sections 2 and 3: belief type probability and probability as a single number. In our discussion and conclusion, Section 4, we will emphasize that our formal approach to inference and decision is of normative nature. It precedes and is to be distinguished from empirical and descriptive accounts. Trying to bend the normative approach in order to satisfy descriptive criteria and the intuitive perception of human inference and decision behavior would be a misunderstanding.

2. Subjective (personal) probability: what it means and what it does not mean

The belief type interpretation of probability is retained here because other interpretations, such as the frequentist definition, involve assumptions that are known to fall short of the features of the real-world applications they should be able to capture. Frequentist ideas involve the notion of repetition under stable conditions, and the counting of the number of times a particular outcome occurs. This includes extensions to idealisations, such as long run repetitions in the context of an infinitely repeatable experiment. Although this perspective may have some appeal for classroom experiments and artificial conditions (e.g., flipping coins or rolling dice[3]), it readily reaches its limits with real-world situations that are highly distinctive and non-repeatable. This leads to applicability problems that continue to frustrate generations of practitioners, yet the frequentist approach continues to be the predominant perspective taught in basic science education. This is all the more surprising given that there is an alternative – the belief type interpretation – that is capable to cope with the features of real world events. What is more, paradoxically, it is fraught with prejudice.

The belief type interpretation differs from the frequentist viewpoint in two main respects. First, the belief type interpretation of probability does not require that a target event (or, experiment) be repeatable. Second, probability is not seen as a property of the real-world – also sometimes called system – under observation. Instead, probability is considered as a property of the person who contemplates about the real-world. For example, when we consider the truth or otherwise of a proposition regarding, for example, the outcome of an experiment (e.g., the comparison of DNA profiles of questioned and items of known origin), the frequentist might say that in his view the probability of the event of encountering corresponding DNA profiles is the long-run relative frequency of this outcome in the experiment under investigation, but that he does not know this value (relative frequency). So, the frequentist would express himself in terms of 'not knowing the probability', or 'unknown probability'. Taking this answer literally – probabilities being unavailable – leads to the conclusion that the scientist cannot offer help with the problem of interest, because the use of a likelihood ratio in forensic science requires him to be able to specify probabilities.

In the belief type interpretation of probability, the above impasse does not occur. Indeed, when considering probability in terms of a person's belief, it is meaningless to say that probability is not known to that person. A person necessarily knows what she thinks or else should not be considered entitled to talk sensibly about the uncertain proposition of interest. But notice that the knowledge of two persons regarding the truth or otherwise of a given proposition may differ, and sometimes substantially so, which will result in them assigning different probabilities. So differences in assigned probabilities are not surprising, they merely reflect the capacity of the framework to account for inter-individual differences in personal knowledge.

The above does not mean, however, that the adherents of personal probability may not consider, too, data from repeated trials where they are available. As noted by De Finetti [9, p. 334]:

> "Those interpretations of the notion of probability in a (would-be) objective sense which are based on symmetry (the classical conception; equally likely cases), or on frequency (the statistical conception; repeated trials of a phenomenon), provide criteria which are also accepted and applied by subjectivists (…). It is not a question of rejecting them, or of doing without them; the difference lies in showing explicitly how they always need to be integrated into a subjective judgment, and how they turn out to be (more or less directly) applicable in particular situations. If one, instead, attempts to force this one or that one into the definitions, or into the axioms, one obtains a distorted, one-sided, hybrid structure."

Clarification of this point can also be found in the writings of Lindley [e.g., 13] who prefers to keep the concept of relative

[2] Throughout this paper, we will take 'belief type', 'personal' and 'subjective' as referring to the same interpretation of probability.

[3] Note however that even for this kind of experiment, the assumption of repetitions under stable conditions cannot be uphold, as with increasing numbers of repetitions, the coins and dice may wear out.

frequency in a more strict sense as a summary of available data that do not have any uncertainty attached to them (i.e., the number of times something is observed divided by the total number of observations), whereas probability refers to an individual's belief about an uncertain proposition of interest. Surely, Lindley argues, data are useful to inform one's beliefs, but one should guard against directly identifying (relative) frequency with belief, precisely because one may run into kinds of complications outlined above.

It follows from the above that personal probabilities are at least as informed, in terms of data, as other types of probabilities. This is an important message because one frequently encountered concern is that personal beliefs are arbitrary and speculative, proffered in unfounded ways and devoid of any reasonable justification. Where probabilities are given in this way, this is a cause of concern, and we would agree then with Morrison and Enzinger [14] that such probabilities should not be held acceptable. However, rejecting belief type probability as a concept altogether is an extreme position that would discard the informed and defensible usage of belief type probabilities.

To some extent, skeptical reactions are understandable, not least because beyond the rules of probability themselves, there are no formal constraints for the assignment of probabilities. Probability, thus, is a very liberal concept, but it comes at the price of asking scientists to take responsibility for their evaluations [8, p. 179]:

> "You are completely *free* in this respect and it is entirely your own *responsibility*; but you should beware of superficiality. The danger is twofold: on the one hand, You may think that the choice, being subjective, and therefore arbitrary, does not require too much of an effort in pinpointing one particular value rather than a different one; on the other hand, it might be thought that no mental effort is required, since it can be avoided by the mechanical application of some standardized procedure."

This is a crucial point in understanding what the liberal concept of probability entails. Dawid and Galavotti, for example, state that

> "(…)[w]e (…) argue that de Finetti's claim should *not* be taken to suggest that subjectivism is an anarchist approach according to which probability can take whatever value you like. De Finetti struggles against *objectivism*, or the idea that probability depends entirely on some aspects of reality, not against *objectivity*. He strongly opposes the "the distortion" of "identifying objectivity and objectivism", deemed a "dangerous mirage" (…), but does not deny that there is a *problem of objectivity* of evaluations of probability." [6, p. 98]

Showing, thus, in a transparent and logical way, what types of information (data) the scientist relied upon and how exactly they were used for eliciting probabilities, remains a major challenge. Recipients of expert information may have good reason to remain unconvinced by a given scientist's account, and feel justified to refer to the scientist's use of probabilities as "best guesses" and "mysterious" [16, p. 65] (i.e., those situations rightly critizised in [14]). But again, flawed practice in individual cases and difficulties in perception of personal probabilities do not invalidate the concept as such. It merely shows that efforts are still needed to further the understanding of what belief type probabilities really mean and do not mean.

The extent to which this is a challenge is illustrated by the ENFSI Guideline For Evaluative Reporting in Forensic Science [19]. This guideline provides a typical example of personal probabilities encountered in conjunction with the notion of expert experience. The ENFSI document mentions an expert's personal experience as one among the many possible sources for probability assignment:

> "Such data can take, for example, the structured form of scientific publications, databases or internal reports or, in addition to or in the absence of the above, be part of the expert knowledge built upon experiments conducted under controlled conditions (including case-specific experiments), training and experience." [19, at p. 19]

The difficulty with this perspective is that it may be misread as meaning that even a vague reference to personal experience is on an equal level with more formal and scrutinized data (e.g., from scientific literature). But, this is not the case. Structured and disclosed data sources clearly enjoy a privileged position. The guiding strains here are transparency, disclosure and the scientist's capacity to justify quantified probability statements:

> "(…) personal data such as experience in similar cases and peer consultations may be used, provided that the forensic practitioner can justify the use of such data. For example, if the assessment is based on experience, the forensic practitioner will be able to demonstrate the relevant and documented previous professional activity." [19, at p. 15]

From the above discussion we retain the following intermediate summary:

- Applications of probability in forensic science and the law are a challenge for all interpretations of probability, yet the belief type interpretation presents advantages over other interpretations connected to frequentism and objectivism, mainly regarding operational criteria such as applicability. Even the fiercest challengers of probability applications in the law concede that it is personal probabilities, if any, that may have their place in the law:

> "None of the conceptualizations of probability except probability as subjective degrees of belief can function at trial." [1, at p. 104]

- It is not constructive to oppose subjectivist belief type probabilities to other seemingly more objective interpretations essentially because objectivity cannot but exist within a framework of assumptions that rest upon personal choice, or at least intersubjective convention.
- Properly understood, subjectivist belief type probabilities are *not* arbitrary, speculative and unfounded; they are not by definition arbitrary. They are based on at least as much information and relevant data as other definitions of probability. What is more, personal probabilities come with an explanation of how the relevant conditioning information was used for probability assignment. Such a justification of how exactly information is integrated into judgment is a feature that represents an advantage over mechanistic default procedures of probability assignment that can be operated by individuals even without sufficient understanding of the task at hand.
- Taken seriously, personal probabilities can provide value to the process because they require the scientist to adopt a disciplined approach and responsibility in the process of assigning probabilities. Commitment to personal probabilities thus is neither a detriment to the process, nor a derive to vagueness, as noted by De Finetti [7, p. 474]:

> "Such ideas are however distressing for some people, who consider objectivity, in the strictest sense, as a necessary attribute of probability and of science. But regret for losing the faith in the perfect objectivity of probability, and hence of science, is unjustified. Nothing is lost but what was a mere illusion."

Having provided further details on the general nature and meaning of belief type probabilities, we now turn – in Section 3– to further discussion of selected properties of probabilities, in particular the issue of understanding probabilities (and hence likelihood ratios) as single numbers. To do so, we will introduce and rely upon fundamental results from decision theory [4]. These arguments have not been introduced so far in this Special Issue, yet we hold that they should be part of an informed discourse, mainly because they provide further and independent justification, and hence argumentative support, for our previously defended position [5,18].

3. Expert probability reporting as a decision

An uncontested starting point of the discussion in this collection of articles is that the forensic scientist is required to report in terms of probabilities. Specifically, in order to be balanced, the expert will provide a probability for the results given each of the competing propositions, representing positions of the parties in the process. The expert thus faces the following fundamental question: 'What probability should I (you, anybody acting as a forensic scientist) report?' On taking a close look at this question we realise two main aspects:

- First, the fundamental question regards the scientist personally in the particular situation of forensic reporting in the legal process.
- Second, the issue the scientist is concerned with amounts to a question of the kind 'what to do?'.

It follows from this that the forensic scientist is confronted with a question of decision-making. It is the question of how to decide the probability to be reported. The underlying idea, thus, is to consider expert probability reporting as a decision problem. Below, we will approach this question from a formal point of view, review results from existing literature, and point out the relevance of these insights for the discussion on 'precision' (of probabilities and likelihood ratios) dealt with in this series of papers.

The standard decision theoretic approach to expert probability reporting involves the usual elements, which are decisions, states of nature, associated probabilities and a measure of the desirability or undesirability of the decision consequences. We now explain these ingredients in turn and illustrate them through a general example. The available decisions d are the probabilities that may be reported. These are the numbers in the interval between 0 and 1, including these endpoints. As states of nature, suppose that you are interested in whether a peak seen in an electropherogram is an allelic peak for the locus of interest, or if it is not (and hence is something else, such as a drop-in event). Let us denote these two propositions as A (the observed peak is an allelic peak) and $\bar{A}$ (the observed peak is an artifact). Suppose further that, based on all knowledge and available information, your probabilities (beliefs) for theevents A and $\bar{A}$ are, respectively, $\Pr(A)$ and $\Pr(\bar{A})$, with $\Pr(A)+\Pr(\bar{A})=1$.

The measure of the desirability or undesirability of the decision consequences requires some further explanation. Consider first that either A or $\bar{A}$ is the case, so that we will wish you to make a decision to report a high probability d for the event A if that event is true, and a low probability for the event A if that event is false (and hence $\bar{A}$ is true). Note that the value d that you decide to report need not be equal to $\Pr(A)$. However, through Eq. (1) it can be shown that the best decision, according to the criterion given there, is for the reported probability d to be equal to $\Pr(A)$. The argument involves the assessment of the quality of a particular decision (number) d to serve as the probability to be reported. This assessment is based on what is called a scoring rule. A scoring rule identifies the truth and falsity of a proposition with the numbers 1 and 0, respectively. This will allow the reported probability d to be compared to these truth values. Next, one way to define a score is to consider the square of the difference between the reported probability d and the truthstates 1 and 0. As may be seen, clearly, assigning probability $d = 1$ (or $d = 0$) for a true (false) event will result in a zero score (or, penality). But there are also other ways to define the score, for example, based on the logarithm [11]. The reason why we mention the quadratic score here is that it is a very general and widely known rule, and has particular properties that we will explain in more detail below.

The above definitions provide a starting point. They describe the main ingredients of the decision problem, but they do not yet answer the question 'what probability d should I report?'. To answer this question, we need a way to qualify the goodness of a decision, but not under the assumption of knowing the truth or otherwise of the event, say A for example, which we already did by defining the score, but when we are uncertain about the truth or otherwise of A. The solution to this is to consider a weighting of the scores obtained under each state of nature by the respective probability of each state of nature. This leads to the notion of expected score ES for decision d:

$$\mathrm{ES}(d) = (1-d)^2 \Pr(A) + (d)^2 \Pr(\bar{A}) \tag{1}$$

An expected score can be calculated for each decision d, and these expected values serve the purpose of providing a criterion that allows us to compare the various decisions d. Stated otherwise, we characterise the available decisions by their expected score and this comparison provides the basis of decision. The crucial questions in this comparison are: in what sense is one decision better than another? And, what do we consider as the best decision? One common way to answer these questions is to argue that one should choose the decision d with the minimum expected score.

The above development[4] leads to a series of noteworthy results. First and foremost, the decision that minimises the expected score is $d = \Pr(A)$. In words, this means that the optimal decision in this framework is to report the probability that corresponds to one's actual belief. Any reported probability $d \neq \Pr(A)$ has a higher expected score, and hence would be less optimal. Operating under a quadratic score, and accepting that it is in one's interest to minimise expected penalty, thus is an incentive for the reporting scientist to state his actual beliefs sincerely in terms of probability.

[4] We leave aside further mathematical details and derivations [e.g., 4,12].

As a brief numerical illustration, suppose that the scientist observes a very low peak height in the electropherogram whereas other peaks at the same and other loci are much higher. This would make the scientist consider it improbable that the observed peak is a genuine allelic peak. Suppose that the scientist's belief, according to all the available knowledge and information (which may include mathematical modeling [2]), is $\Pr(A) = 0.1$. The expected scores for a selection of possible decisions d around the decision with the minimal expected score, that is $d = \Pr(A) = 0.1$ (shown in bold), are as follows:

d :	0	…	0.07	0.08	0.09	**0.10**	0.11	0.12	0.13	…	1
ES(d) :	0.1000	…	0.0909	0.0904	0.0901	**0.0900**	0.0901	0.0904	0.0909	…	0.9000

The ES may also be plotted as a function of d to show that the ES has its minimum at $d = \Pr(A)$. This example thus illustrates that the expected score for stating $d = \Pr(A)$ is not zero, but allows one to avoid a prevision of an additional score associated with any decision other than $d = \Pr(A)$. The quadratic scoring rule thus encourages one to state one's probability honestly, which is why the rule is also called a 'proper' scoring rule (there are other proper scoring rules [15]). As an aside, notice also that there is only a single number d that is optimal under this scoring scheme, excluding thus the statement of a set of values or an interval as solutions for probability reporting. This result thus is relevant to the discussion on precision presented in this collection of articles.

Our presentation of scoring rules in this section has focused on a discrete proposition with only two outcomes. The logic extends to uncertain quantities that take values (outcomes) $\{o_1, o_2, \ldots, o_n\}$ and for which the scientist is required to state his probability distribution $\{p_1, p_2, \ldots, p_n\}$, with $\sum_n p_i = 1$ for $i = 1, 2, \ldots, n$. The scientist must thus decide what number to assign to the various outcomes $\{o_1, o_2, \ldots, o_n\}$. For each of these outcomes, there will be a single probability to be assigned. Intervals only arise if one asks a question of the kind 'How sure are we that the uncertain quantity is, for example, comprised between o_3 and o_6?'. However, the answer to this will still be a single probability, that is the cumulative probability $\sum_{i=3}^{6} p_i$. As noted in Section 1, the notion of interval refers to ranges of values for the uncertain quantity. It does not refer to the cumulative probability assigned to this interval. A further point worth mentioning at this juncture is that the scoring scheme presented in this section also works for expert assignment of conditional probabilities.

In the wider context of forensic science, scoring rules are valuable as a device to encourage proper probability statements from experts because experts sometimes tend to round off small and high probabilities to zero and one, respectively, even though they do not have complete knowledge about the target event of interest. For example, it is sometimes said that the probability of an error is so small that it can be considered as impossible, or a practical impossibility. Similarly, it is sometimes claimed – especially in the so-called individualization/identification fields (e.g., fingermarks, toolmarks) – that the features observed in a mark of unknown source could not possibly be observed in a person other than a given suspect who is found to have corresponding features. Clearly, with such statements, scientists would claim more knowledge than they actually have. Having imperfect knowledge means, by definition, that one's probability is different from zero and one. Proper scoring rules do not encourage extreme probability statements such as $d = 0$ and $d = 1$, because of the extreme penalty that will incur if the true state of the event of interest is the contrary of what one thought.

4. Discussions and conclusions

We have argued in our contributions to the collection of articles in this Special Issue that two crucial points in discourses about the likelihood ratio are, on the one hand, a clear view about the nature of its components – probabilities – and, on the other hand, the ways of assigning values for them. We have argued in favour of belief type probability because it is centered on the individual, and this is what is happening in the problem domain that concerns us: individuals, such as scientists, are required to capture and express (quantify) their uncertainty, given the best of their knowledge, with respect to matters that are – with varying degrees – not completely known to them. In essence, thus, forensic science is about real persons required to formulate their knowledge faithfully. As Ian Evett has noted,

> "(…) I will settle for a simple premise: forensic *science* is a state of mind, I mean that whether a particular individual is behaving, at a given juncture, as a scientist can be determined by the mental process underlying his/her actions and words." [10, p. 121]

To the best of our knowledge, there is no demonstration of the claim that expert utterances are anything else than expressions of personal knowledge – though that knowledge may be shared by several experts in the relevant scientific community. It is unsound to refer to these expert utterances as real quantities, objectively existing entities or objective probabilities. There may, occasionally, be (relative) frequency information, but these are *data to inform probabilities*. It does not define probability.

It is now widely agreed, if not a fact, that views on probability are subject-centered, and hence that it is the proper role of experts to provide values for the components of the likelihood ratio. But a question immediately following from this is: 'What do we think those probabilities should be?' and 'How can we assess the quality of those probabilities?' These are intricate questions that do not have easy answers. They trouble many discussants. Our answer to this challenge is that the forensic expert faces a reporting problem that can be appropriately considered as a decision problem: it is, fundamentally, the problem of deciding what probability to report. Through probability theory, we can rigorously state the criteria to which we would like expert probabilities to conform and how to assess (or, 'score') reported probabilities. Decision theory then also devises a strategy of how the expert can state probabilities properly. What is more, the decision theoretic regime actually encourages faithful probability statements. As a further result relevant to the current discussion, the decision theoretic development leads to the conclusion that stating a single probability – rather than an interval – is the optimal decision.

We are not suggesting that probability reporting in forensic practice be explicitly subjected to a proper scoring rule system. We have used this analytical framework merely as a further route of argument in support of understanding the nature of probabilities as personal beliefs, calling upon the reporting scientist to take personal responsibility in assigning probabilities – that is, deciding what probabilities to report – rather than conveying the (in our view misleading) impression that they are reporting on true but unknown objective quantities.

Our conclusion, thus, is that looking at probability as a decision allows us to better understand the concept – probability – about which we ought to report in the first place. We also conclude that the proper way of proceeding consists of devising practical procedures, such as probability as single values, following clear statements of the fundamental concepts, not the reverse. Hence we can avoid defining probability descriptively as a way to circumvent difficulties in probability assignment, such as through intervals or notions such as imprecision. Our preferred solution, belief type probability, also features an integrative and reconciling perspective rather than a divisive view: no probabilities can be provided without making personal assumptions at least at some point[5]. Belief type probabilities thus are inevitable, as they amount to decisions facing any expert who is required to state his state of knowledge probabilistically. Arguably, there are no objective probabilities, but at best probabilities on which several individuals may find intersubjective agreement. This favours an open and transparent dialog on how probabilities ought to be assigned, and on what data these assignments ought to be based. Not only shows this that belief type probabilities are at least as informed as any other allegedly more objective definitions of probability, it also directs us to what critical discourse should focus: on the foundations of expert opinions, rather than on abstract controversy over objectivity.

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[19] S.M. Willis, L. McKenna, S. McDermott, G. O'Donell, A. Barrett, B. Rasmusson, A. Nordgaard, C.E.H. Berger, M.J. Sjerps, J.J. Lucena-Molina, G. Zadora, C.C.G. Aitken, T. Lovelock, L. Lunt, C. Champod, A. Biedermann, T.N. Hicks, F. Taroni, ENFSI guideline for evaluative reporting in forensic science, Strengthening the Evaluation of Forensic Results Across Europe (STEOFRAE), Dublin. 2015.

[5] This has also been referred to as 'De Finetti's mouse-trap': *"Erzähle mir, welche Variante des Objektivismus du vertrittst, und ich will dir sagen, auf welchem Weg du in de Finettis Mausefalle gelangst!"* (italics as in original) [17, p. 27] This can be translated as: "Tell me what variant of objectivism you support, and I well tell you in what way you fall into De Finetti's mouse-trap." Stegmüller argues here that one is obliged, at some point, to admit that one is presupposing the notion of personal probability.