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Short communication

Whose DNA is this? How relevant a question? (a note for forensic scientists)

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ABSTRACT

This communication seeks to draw the attention of researchers and practitioners dealing with forensic DNA profiling analyses to the following question: is a scientist's report, offering support to a hypothesis according to which a particular individual is the *source* of DNA detected during the analysis of a stain, relevant from the point of view of a Court of Justice? This question relates to skeptical views previously voiced by commentators mainly in the judicial area, but is avoided by a large majority of forensic scientists. Notwithstanding, the pivotal role of this question has recently been evoked during the international conference "The hidden side of DNA profiles. Artifacts, errors and uncertain evidence" held in Rome (April 27th to 28th, 2012). Indeed, despite the fact that this conference brought together some of the world's leading forensic DNA specialists, it appeared clearly that a huge gap still exists between questions lawyers are actually interested in, and the answers that scientists deliver to Courts in written reports or during oral testimony. Participants in the justice system, namely lawyers and jurors on the one hand and forensic geneticists on the other, unfortunately talk considerably different languages. It thus is fundamental to address this issue of communication about results of forensic DNA analyses, and open a dialogue with practicing non-scientists at large who need to make meaningful use of scientific results to approach and help solve judicial cases. This paper intends to emphasize the actuality of this topic and suggest beneficial ways ahead towards a more reasoned use of forensic DNA in criminal proceedings.

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Let us devote a few moments of thought to literature dealing with forensic DNA evaluation published over the past few years, papers on forensic DNA presented at international conferences (for example, the conference "The hidden side of DNA profiles. Artifacts, errors and uncertain evidence" in Rome, Italy, 27th to 28th April 2012), international (corporative) standard DNA procedures and guidelines, the form of DNA proficiency tests by recognized professional organizations (such as the ISFG), and try to address the following question: 'What is the shared point between these documents, presentations and resources?' There may be various replies to this. Here, we wish to focus on one that – in our view – appears forthright and is one of concern: the resources reflect a partial misreading of the way in which scientists should assist the judiciary in assessing results of DNA profiling analyses.

This misconception arises at a time when scientists operate analytical techniques that are so powerful that they allow them to obtain profiling results even from tiny stains, or physical matter that is actually not visible. It thus is currently possible to obtain

DNA profiling results for locations where no particular biological material is directly recognizable. To further complicate matters, even if there is visible staining, it may be that it is degraded, but bears invisible material from another source that is in better condition, and it is this latter material that will give rise to profiling results. When such potent analytical techniques meet highly variable real world conditions, the obvious suggestion would be that scientists take greatest care to focus on ensuing interpretative issues. But what does this exactly mean and to what degree do scientists comply with this requirement?

Although it is generally desirable and useful that scientists will assist in assessing whether or not particular DNA profiling results might be related to a visible staining, and it is important that the inability to do so should have an impact on considerations of probative value, invoking only an unspecified possibility of an event of contamination, to discard scientific results entirely, is not serving the purpose of justice adequately. First of all, the absence of visible staining to which DNA profiling results could be related should lead to a shift in the definition of the competing propositions of interest. According to a now generally recognized conceptualization, propositions can be hierarchically positioned with regard to, respectively, (i) the source of recovered material,

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(ii) the alleged activities that led to the deposit (or, genesis) of recovered material, or (iii) the legally qualified offense in the case at hand. This is known as the concept of hierarchy of propositions [1,2]. This concept plays a critical role in placing the meaning of DNA profiling results appropriately into context. Beyond particular applications such as kinship analyses, we will emphasize throughout this note that there is a need to consider so-called activity level propositions in cases involving results of DNA profiling analyses obtained for transferable traces or stains.

For the sake of transparency and the honest reflection of the inherently unknown state of affairs, a stringent analysis of the outset suggests that a traditional pair of source-level propositions of the kind “the crime stain comes from the suspect” versus “the crime stain comes from an unknown person” would be more appropriately rephrased in terms of propositions called ‘at sub-source level’, defined as follows: “The DNA is that of the suspect” versus “the DNA is that of an unknown person”. However, consideration of DNA profiling results at sub-source level leads to paradoxical situations. In fact, while courts are typically interested in questions such as ‘how did this DNA get here?’ rather than ‘whose DNA is this?’, propositions at sub-source level precisely address the latter category of questions. In a strict sense, thus, the scientist’s reporting is not tailored to the request of mandating authorities. As a consequence of this, current practice leaves it to the courts to operate a move to higher propositional levels that will better suit their needs, even though this requires taking into account issues such as transfer, persistence, search and recovery performance, as well as contamination. By nature, these are all highly technical aspects, but also depend heavily on circumstantial factors. It is questionable, thus, if the courts can be expected to meet the challenge of moving to higher propositional levels where the construction of sound arguments demands the proper understanding of the aforementioned factors, and solid empirical knowledge. Even most scientists would currently refrain from evaluations at this level essentially because they feel that empirical data in these matters is currently too scarce. Actual forensic practice, yet forensic science in general, thus demonstrates a considerable gap between the information offered by scientists and the very needs of the judiciary.

It is also not rare to note that discussions about DNA profiling results coming from mixtures or traces with low quantities of DNA focus on the degree to which particular signals in raw data (electropherograms) are indicative of the true donor(s) allelic constitution(s). Although allele designation is a crucial step in the use of DNA in criminal proceedings, it is far from the questions of primary interest to the courts. Surely, the courts are interested in any information about traits of the individual(s) that are at the origin of particular physical matter detected in connection with a crime – so it is crucial that such determinations are made accurately – but what courts are really interested in is an assignment of probative value once that DNA profiles have been obtained, in whatever form, single or replicate. But, what is such a probative value and why do many case-working scientists currently struggle to address this request adequately? The fundamental question when evaluating the probative force of results of forensic examinations is: “What is the capacity of these results to distinguish between the competing propositions put forward *at trial*?” Any discourse on the probative value of scientific findings thus starts with the definition of the competing propositions of interest. Accordingly, scientific results do not have an intrinsic probative value that scientists who conduct examinations on material and seized items could derive in isolation from the framework of a case. Instead, the value of findings can only be specified in a given context. This redirects the discussion to the hierarchy of propositions that, itself, is closely connected to the circumstances of a case at hand. This hierarchy is not rigid,

however, but seeks to offer a flexible template to help position propositions with respect to the issues that the courts are concerned with.

The ultimate propositional level is called ‘crime-level’ and can be exemplified with propositions of the kind “the suspect is the offender” versus “an unknown person is the offender”. Often, scientific findings cannot readily be considered in the light of such an advanced level of propositions, essentially because this requires a broad knowledge about circumstantial information that clearly lies beyond the scope of the expert’s area of competence (notably, intent to commit the crime). It is for this reason that the hierarchy of propositions also covers lower levels, such as the activity-level or source-level. In the context, activity-level propositions are important because they embrace the possible processes – in particular, activities of the allegedly involved individuals – that led to the scientific findings in the case at hand. The degree to which target activities satisfy legal definitions (e.g., particular crimes), then remains a duty of the judiciary. While the relevance of this is not contested, it may thus be questioned why scientists persist in addressing their findings given source-level propositions.

This question is all the more disconcerting because a given level of propositions, or an expression of probative value at a given level, cannot by default be extended to another level of propositions. The failure to recognize this by either scientists or other members of the judiciary is also known as a violation of the hierarchy of propositions. That is, observing a correspondence between analytical characteristics of a trace and comparison material from a suspect (source-level) does not necessarily imply support for the proposition according to which the suspect has actually *left* the crime stain at hand (activity-level). Little seems more obvious than this assertion, most notably when it is made beyond reference to a given case, but yet experience teaches us all how easily and recurrently this precept is contravened in legal practice.

Source-level propositions require not much more than information about the rarity of the corresponding characteristics, expressed with reference to population genetic considerations. Eventually, formulaic expressions of probative value may also be taken into account, but still the respective propositions remain formulated at source-level. The obvious advantage of the reduced collection of factors involved in source-level approaches is that they can be formulated rather independently of any context. They typically reduce to a formula that any analyst with at least some awareness of basic computations will be able to use. But this comes with a high price: the usefulness of the computed result *for the case at hand* may be severely limited, if not completely devoid. This is not to suggest that formulae for evaluation at source level are ‘simple’ – indeed they can be so highly elaborated that end users may not even be proficient enough to actually understand their derivation. This is also not to contest that the comparison of DNA profiles can help to exclude individuals as potential sources or, otherwise, select candidate individuals for further investigation. The point is that the formulation of propositions at source-level as such often segregates a given computational result from the very issues in a case at hand. Moreover, when considering probative value in terms of a likelihood ratio, it cannot be used as a multiplicative device – which is one of the very strengths of this approach to reasoning under uncertainty – if the propositions under which the scientist chose to work are different from those retained by the recipient of expert information.

Substantially more effort is needed for evaluation at activity-level because it demands evaluators to take into account further phenomena such as transfer, persistence and background presence due to, possibly, other and legitimate actions. In a large majority of criminal cases, this inferential perspective of evaluation with respect to selected propositions is missing. In fact, discussions about source attribution are commonly paired with other topics

such as contamination and transfer, but this amounts to a thematic derivation that is of aimless from an argumentative point of view. That is, if the question of interest is that of inferring the *source* of DNA, then the rarity of the compared characteristics in a relevant population is by far the main influencing factor – leaving aside, for the time being, considerations of the probability of error that may outweigh rarity indicators. Issues such as contamination or transfer are perfectly irrelevant when inquiring about source alone. Indeed, to formulate it in more general terms, the detected analytical characteristics are just what they are independently of how the trace arrived there where it was detected. Issues such as contamination and transfer become relevant in a case against a corresponding suspect only when the target propositions are formulated on the activity-level and stipulate, for example, that the suspect conducted the incriminated activity (e.g., assaulted the victim) versus an appropriate alternative. Although it is such propositions that obviously appear to be considered by courts in many cases, they do not do so in a proper way when it comes to presenting or debating the probative value of the DNA profiling results. This is unfortunate because the probative value of DNA profiling results may substantially differ between source- and activity-level, and suggesting an assessment at source level as one at activity level by spurious argument about contamination and transfer places defendants under acute risk of unwarrantedly incriminating conclusions.

In the area of forensic DNA – and similarly for other transfer traces, stains or marks – we emphasize that, throughout, a meaningful and balanced assessment should help to address issues relating to the alleged activities to which DNA is thought to be associated, rather than isolated considerations of source of any recovered material. To further substantiate this point, suppose a scenario with traces that bear only a small quantity of DNA, without further details being available on the nature of the biological material at hand. Would there be a *real* point of deliberating about source level propositions? If evaluated at source level, regardless of the alleged circumstances, the finding of a correspondence in analytical characteristics between the traces and control material from a suspect will virtually always provide support – and, most often, very strongly so – for the prosecution's proposition. Typically, that strength of support would in some general sense be inversely proportional to the rarity of the DNA profile. It is important to notice, however, that such an assessment would only be based on the *intrinsic* features (i.e., the genetical profile) of the recovered material. The very same conclusion would have been reached had a large quantity been recovered, or whatever other quantity. The same conclusion would also have been reached if the corresponding profile had been found for material recovered in any position, whatever its relevance or compatibility with the circumstances of the case at hand. Stated otherwise, the same value would be assigned in fundamentally different scenarios that bring in diametrically opposed *extrinsic* features that have their say about the alleged activities. For example, finding a single low quantity bloodstain, although 'matching', may not be something well in agreement with a given alleged proposition of aggression (which would make us expect abundant traces of undried blood), whereas such a finding may be well in line with a particular defense proposition. Conversely, finding a large amount of biological material, or several stains with corresponding profiles, could be well accommodated within a scenario of aggression, whereas such a finding may not agree well with the defense's proposition. A fit-for-purpose evaluation of findings should thus concentrate on the alleged activities in order to bring to the fact-finder the appropriate strength associated with *all* the forensic observations, that is both, intrinsic and extrinsic features.

This call is all the more disconcerting as there are even laboratories that devote substantial instrumental and human resources to the analysis of single cells while remaining fundamentally incapable of addressing questions of the following kind: 'What is the probative value of a DNA profile of a single cell found to correspond with the profile of a named individual?'. It is also disconcerting as there still are many forensic and legal practitioners who would be prepared to accept the categorical but fallacious conclusion that a reported match in such a case signifies or implies the establishment of common source, as illustrated, for example, during panel discussions held at the Rome conference mentioned above.

But even if one should not agree that the field's persistence with source-level propositions is detrimental to an operationally meaningful assessment of DNA profiling results, one would still need to admit that the way in which source-level evaluations are currently conducted – in particular where they amount to reported likelihood ratio values in the billions (i.e., based solely on the rarity of DNA profiles) – is plainly shortsighted because the probability of (laboratory) error is not taken into account. Despite being described and discussed in both forensic literature and practice since a long time, the latter factor is still not included in routine source-level assessments. Since current knowledge and data does not allow to regard the probability of error to be anywhere near as small as conditional profile probabilities, the probability of error tends to completely dominate the value of the likelihood ratio – possibly rendering the rarity of the corresponding characteristics virtually ineffective. It is thus scientifically unacceptable and unsound to ignore the probability of error and, worse, to continue research that focuses on population studies rather than on works that help to better circumscribe the probability of error, yet the phenomenon of error over the whole DNA process as such, and ways how to assess this particular issue on a case-based level.

This allows one to conclude that current reporting practices for forensic DNA at source level are deficient in at least two respects. Firstly, source-level propositions ignore vital aspects of the processes and actions that led to the genesis of the analyzed biological material. It is often argued that the move from source-level to higher propositional levels such as activity-level should be entirely confined to the judiciary, but this would disregard the fact that scientists could offer relevant knowledge and advice on aspects that the judiciary cannot (or, not exclusively) be expected to be proficient (e.g., phenomena of transfer, persistence and recovery). Secondly, the source-level assessments actually offered by scientists may misrepresent the probative value by many orders of magnitude if they are restricted to rarity expressions for the corresponding characteristics (i.e., when no probability of error is taken into account).

Who is to make the principal effort to make progress towards a more balanced, meaningful and responsible use of forensic DNA profiling results? Participants in the justice system, namely attorneys, judges and jurors, can hardly change their questions of interest: the choice of competing propositions is mainly dictated by characteristics and circumstances of the case, with activity level as an often unavoidable minimum hierarchical level. Scientists, in turn, can be expected to operate in a more flexible environment despite the fact that their role varies strongly in different court systems, namely the adversarial system in many English-speaking countries, as opposed to the inquisitorial systems used in many countries of Continental Europe. In essence, it is experts who provide information to lay persons (juries, judges, attorneys for the parties) on forensic science matters that – most often – these persons know only little about. The duty of experts should thus encompass the task of helping the court understand how to frame inference problems in terms that are scientifically relevant.

Otherwise, vital scientific information may be kept from the process.

Although current forensic knowledge may restrict the extent to which scientists can offer reporting beyond source level, the nature of forensic science is such that focused research can be conducted, so as to generate new knowledge that can assist scientists in progressing towards reporting at higher and more relevant propositional levels: the community of forensic DNA specialists have it in their hands to choose this path of research and to define the relevant priorities. The effort to launch extensive and structured research projects in this field can only be supported

by funding agencies who have to be made aware of the challenges and lacks of the current forensic practices. This note argues in support of a broad agreement and common understanding of this topic because this is essential for making this endeavor a success.

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