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**Reply: Letter to the Editor:**

**"Is the definition of task-irrelevant contextual information black and white?"**

We welcome the debate on 'task-irrelevant' contextual information and 'cognitive bias' as our review and outlook on this topic is supposed to be thought provoking. We acknowledge the important contributions made by Dror, Thompson, and others trying to discover, understand and overcome cognitive bias in forensic decisions. At the same time, we have reservations about some of the claims made in the letter.

First, the letter seems to imply that the definition of task-relevant information as proposed (non-unanimously) by the U.S. National Commission on Forensic Science in 2015 (1) has been adopted and adhered to everywhere in the world. Imposing norms and definitions will not prevent forensic scientists, as well as citizens in different countries, to deviate from rules and guidelines. Otherwise there would be no cognitive bias, and no deviant behavior. Indeed, a study by Gardner, Kelley, Murrie, and Dror (2) illustrates inconsistencies in what forensic scientists deem as task relevant. A sizable fraction of forensic scientists considered task-irrelevant contextual information differently from the definition given by the U.S. National Commission on Forensic Science (e.g., 6-10% would review suspects previous criminal history; 24.4-29.5% would review the suspect's statement; and, 19.5-30.1% would review a confession). Second, our concerns about methodological shortcomings in the literature on cognitive bias were not acknowledged in the Letter to the Editor. We will discuss each of these points in turn.

**Definition of task-irrelevant contextual information**

‘Task-relevant’ and ‘task-irrelevant’ is portrayed in Black and White in the letter to the editor but the definition may not be as clear cut. The quote from the National Commission on Forensic Science “...*task-relevant during evidence collection and evaluative phases may not be task-relevant during the analytic phase*” instead suggests that in a forensic decision process with preliminary, analytic, and evaluative phases the definition of “task-relevant” information can change. In addition, the formal definition of task-relevant information in the technical appendix (1) uses likelihoods and likelihood ratios to express uncertainty. The likelihood of evidence ‘E’ (e.g., fingerprints) given a proposition ‘P’ (e.g., suspect is source), written as  $\Pr(E|P)$ , relies on inferential statistics rather than first-order (binary) logic. However, establishing a conditional probability  $\Pr(E|P)$ , particularly  $\Pr(E|\text{not } P)$ , is not trivial. It can be difficult to express uncertainty through probability, because this requires a stochastic model. Trying to model the strength of forensic evidence as the result of a forensic process is fraught with problems.

To give an example, assume an examiner tries to match fingerprints from a crime scene with fingerprints of a suspect in a process sometimes referred to as Analysis, Comparison, Evaluation and Verification (ACE-V). Most likely there is a sample of fingerprints suggesting different probabilities for each match. An examiner might go back and repeat parts of the sequential process in order to reach a better conclusion. Ignoring the process of selecting evidence may severely distort conditional probabilities. It is also unclear, what should count as evidence in a fingerprint match given the suspect is not the source? Features that are common among fingerprints? Missing features in a print? Prints from the crime scene that cannot be matched? This quickly taps into knowledge beyond “task-relevant” information.

The definition of “task-relevant” in terms of likelihoods contrasts with the statement in (1): “... *information is task-relevant for analytic tasks if it is necessary for drawing conclusions (i) about the propositions in question (ii) from the physical evidence that has been designated for examination...*” Here the emphasis shifts from the likelihood  $\Pr(E|P)$  to drawing conclusions from the evidence, the probability of the proposition being true (false) given the evidence. Bayes’s rule, written in its simplest form as  $\Pr(P|E)=\Pr(E|P) \Pr(P)$ , provides a suitable framework. However, this approach is dismissed (3) because it uses “prior odds”, knowledge that is not directly related to the evidence (i.e., task-irrelevant according to the letter to the editor). Nevertheless, priors would be compatible with the definition of “task-relevant” information because they affect conditional probabilities. Ignoring priors or assuming equal priors seems appropriate when reaching a verdict but can lead to a well-known fallacy in statistical inference: base-rate neglect is itself classed as a cognitive bias (4). Also, the posterior probability, i.e. the conditional probability that the suspect is the perpetrator given the evidence, is confused with the likelihood, the conditional probability of the evidence given the suspect is the perpetrator, because on one hand it is argued that “task-relevant” contextual information should have probative value, allowing an inference about the proposition, and on the other hand, ‘task-relevant’ information is defined as a likelihood.

If there is no clear causal link and established procedure between “task irrelevant” contextual information ‘C’ and proposition ‘P’, the extended conditional probability  $\Pr(E,C|P)$  and  $\Pr(P|E,C)$  are more difficult to evaluate. It is suggested that such contextual information should be dismissed even if it significantly increases predictive accuracy. In the case of fingerprint matching, contextual information could be additional information the analyst has about an automated fingerprint identification system, experience of how rare or common features of interest are, the quality of the prints, how many other prints were found at the

crime scene, etc... This contextual information can be difficult to translate into probabilities but may help the forensic decision nevertheless. Indeed, Thompson (3) states that “*Forensic scientists may well be able to improve their accuracy by considering task irrelevant information, but only by delving into matters beyond their scientific expertise*”.

As pointed out earlier, it is difficult to reach a universal consensus on what is task-irrelevant, especially if this contextual information leads to better inferences.

### **Methodological issues in previous research**

Our critical review discussed limitations relating to experimental investigations of bias in forensic science. For instance, many studies within the field lack important aspects of experimental design: 1) a control group; 2) appropriate statistical analysis; 3) adequate sample sizes; 4) ecological validity; 5) information about the random assignment of participants; 6) information about instructions on the purpose of the study (5; 6; 7; 8). We believe that because of these limitations at least some recommendations, definitions and implications may have been premature. Proper experimental designs that use adequately powered statistical tests, randomised group allocation (including a control group), and that are ecologically valid need to be conducted before we can move forward.

Because of the limitations in previous research, it is possible that bias due to “task-irrelevant” contextual information (as defined in the letter to the editor) may *sometimes* lead to more accurate decision making (9; 10). This is not a new claim, neither in decision science (11) nor forensic science (9, 10). Further, in a number of experimental investigations (12; 13; 14) it was found that task-irrelevant contextual information (with no probative value as defined in the Letter) may have *no significant impact* on the accuracy of judgments in forensic analysis. Further, Stevenage and Bennett (15) found that knowledge of task-irrelevant contextual

information could even be beneficial, as the effects of said information were dependent on the ground-truth of the forensic evidence being analyzed (i.e., did the contextual information confirm or disconfirm the accurate decision). Despite the common view that ‘cognitive bias’ in forensic decisions has a negative impact on accuracy this needs to be empirically validated.

Although contextual information and bias can be negative and misleading, it can also be used as a ‘sanity check’ of analytical results. For example, contextual information may trigger a reassessment of the evidence, if the results seem unlikely or inconsistent. This may reveal an error that was made during the collection, transfer, and storing of evidence. This would not be possible if the forensic scientist had little or no contextual information provided to them. Furthermore, the effects that task-irrelevant contextual information and cognitive bias have on decision making is complicated, and needs to be addressed in a sophisticated and nuanced way as to respect said complexity.

Dror (9) as well as Thompson (10) have acknowledged that bias can *sometimes* be beneficial. However, at no point did we claim that “task-irrelevant” contextual information should be included by default within the decision-making process. Rather, we believe we have built upon the work of Thompson, Dror and colleagues by adding considerations on why “cognitive bias” in forensic decision making may be beneficial, and by suggesting that further, more rigorous, research is needed before recommendations can be made. We believe that the following statement in the Letter mirrors this key point:

*“While it is conceivable that forensic scientists’ reports might in some unusual instances be more useful to the legal system if they consider information that falls outside the Commission’s bright-line definition of task-relevance (5), the case for routine reliance on*

*such information (if it can be made at all) will need to [be] made in a careful, rigorous manner.”*

### **The ‘Criminalist Paradox’**

We do not recommend that forensic scientists should begin to use “task-irrelevant” contextual information when analysing ambiguous information (as more evidence is needed before recommendations can be given in regard to bias). Of course, we agree that lawyers will be skeptical of forensic scientists using “task-irrelevant” contextual information (3). Finally, we also agree that the criminalist paradox serves as an important argument against the use of task-irrelevant contextual information (6;9;10).

Nevertheless, we do believe that the criminalist paradox should not be a full stop to the debate on the effects of task-irrelevant contextual information on forensic decision making. Further research is needed to evaluate the effects that task-irrelevant contextual information can have on forensic scientist’s decision making in operationally accurate environments (16). In addition, if “task-irrelevant” contextual information increases the accuracy of an expert’s decision (e.g., a fingerprint match) and if this forensic evidence, together with all the other evidence (associated or not), leads to a “correct” jurisdiction, then the criminalist paradox may only be a theoretical paradox of logic. Only if the task-irrelevant contextual information leads to wrong forensic decisions (both at the forensic science and jury level) is there a problem; this is something that future research needs to resolve.

It is also important to remember that forensic decisions are rarely context-free as forensic scientists typically work together with the police and prosecution. Consequently, the forensic scientists and the jurors may take the same contextual information into account – to establish

evidence admitted in court and when passing a verdict. These are different decisions and their accuracy can be evaluated independently even if they share contextual information. Further, if the cognitive bias helps forensic scientists to make the correct decisions, does this automatically convert the “task-irrelevant” contextual information into “task-relevant” or should it be disregarded regardless? These are questions that can only be answered with further discussion and research; something the criminalist paradox may be attenuating.

Future research on juror decision making may extend the work of Thompson and Scuritch (17), as a method of combatting the criminalist paradox from an alternative position. They found that jurors find expert witnesses less credible and are less likely to convict when expert witnesses are cross examined and questioned surrounding the subjectivity of their decision making and the potential for task-irrelevant information to bias their judgments. Furthermore, maybe the criminalist paradox could be tackled at the jury level, by educating jurors and legal actors (judges and lawyers) about bias, contextual information (task-irrelevant and task-relevant) and that certain pieces of evidence may be interlinked (e.g., confession and fingerprint evidence). This may be a more productive way of counteracting the criminalist paradox rather than ignoring both the fact that cognitive bias is inevitable in decision processes (as can arise from extra-legal factors such as experience of working with previous fingerprints (4; 14)) and that bias can sometimes be beneficial (6;9;10). This method may also help to allow jurors to understand that the pieces of evidence that are presented in a courtroom may not be truly independent.

### **Concluding remarks**



At the heart of the debate is the question whether a universal definition and objective procedure (i.e., where cognitive bias is omitted) can be established when making forensic decisions. We believe, however, that the seemingly rigorous definition of “task-relevant” information is open to interpretation. We therefore reject in the letter to the editor that we used a “confused” and “incomplete” definition of task-relevant information, which prevents an intelligent discussion. Instead we question the belief that a definition of task-relevant contextual information is always straightforward and possible. We suggest that a binary distinction between “task-relevant” and “task-irrelevant” may be too restrictive, stifling a meaningful debate about the many facets of contextual information and “cognitive bias” in forensic science.

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