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# The effect of contextual information on decision-making in forensic toxicology

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*ABSTRACT*

The impact of cognitive bias on decisions in forensic science has been demonstrated in numerous disciplines such as DNA and fingerprints, but has not been empirically investigated in the more objective domains, such as forensic toxicology. In the first experiment, participants (n= 58) were affected by irrelevant case information when analysing data from an immunoassay test for opiate-type drugs. In the second experiment, participants (n=53) were biased in their choice of tests, for example, the age of the deceased impacted testing strategy: for older people, medicinal drugs were commonly chosen, whereas for younger people drugs of abuse were selected. Based on the results that examiners analyzing case data may have biases if they are given access to case context, we propose that examiners analysing presumptive test data are blind to irrelevant contextual information. Furthermore, that forensic toxicology laboratories use a protocols consistent, and that any deviations are documented and justified.

Keywords: cognitive bias; contextual bias; forensic toxicology; case strategy; human factors.

# The effect of contextual information on decision-making in forensic toxicology

## 1. Introduction

Forensic toxicology involves the analysis of biological fluids for drugs, alcohol or poisons in order to assess the role of these substances in cases involving human performance (e.g., driving under the influence or a workplace accident), sudden deaths (e.g., a Coroner's inquest) and criminal cases (e.g., drug-facilitated crime) [1]. Although often perceived as 'objective', many aspects of forensic toxicology casework involve interpretation and subjective decision-making, which depend on the discretion of the forensic examiner. It is therefore important to understand the role of cognitive human factors in shaping decisions in this discipline. Cognitive bias is a systematic pattern of error in human judgement [2], and many different forms can affect our perceptions and decisions [2]. These have now been shown to have a significant impact on forensic science [3-6], and the effects are not limited to those disciplines involving comparison of images or patterns [7]; bias may also impact disciplines based on analytical chemistry, such as forensic toxicology [8, 9].

Cognitive bias can emerge from different sources. Some of these sources may relate to the case at hand (e.g., reference materials, irrelevant case information), whereas other sources have nothing to do with the case at hand, but rather with the human examiner doing the work. These sources may emerge from the specific examiner's experience, education, and other personal factors, or from cognitive factors that affect all of us, as they emerge from how the human brain processes information. Figure 1 shows eight sources of bias, emerging from these three categories.

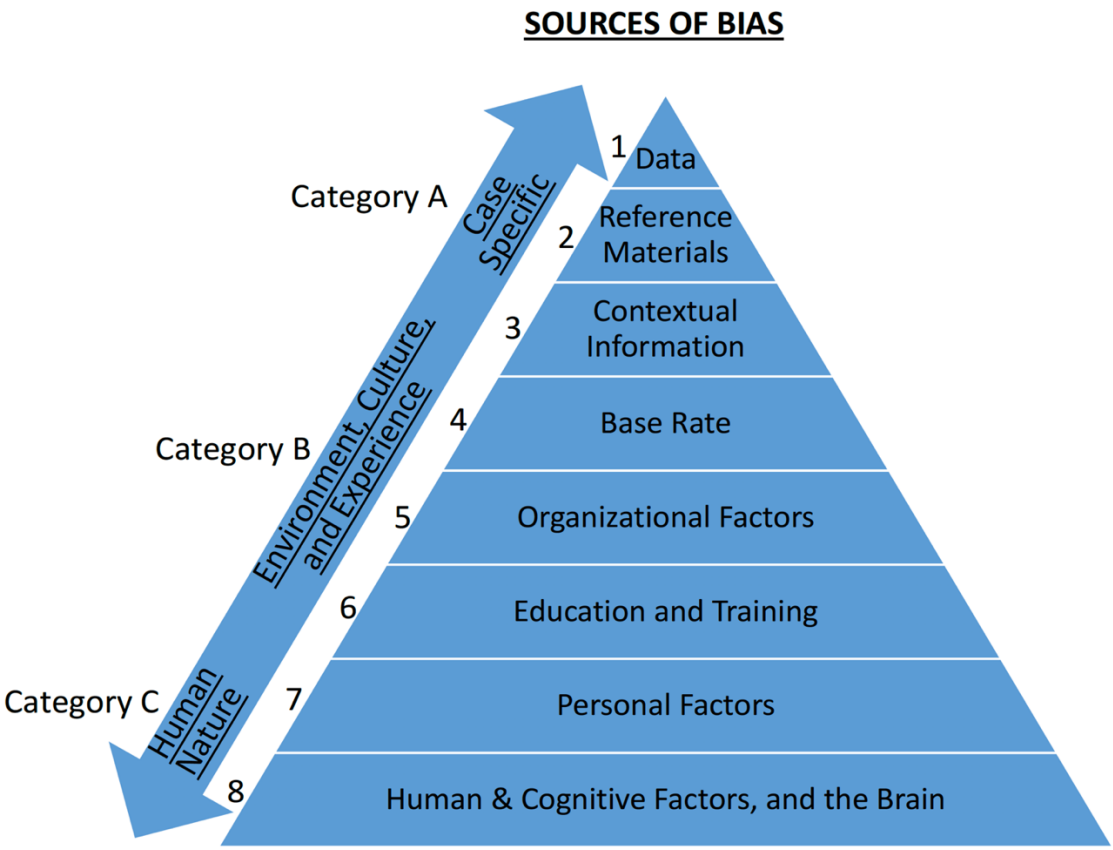



**Fig. 1.** The eight sources of bias that may cognitively contaminate sampling, observations, selection of tests and case strategy, analysis, and interpretation. They are organized in a taxonomy within three categories: starting off at the top with sources relating to the specific case at hand (Category A), moving down to sources that relate to the specific examiners doing the analysis (Category B), and at the very bottom sources that relate to human nature (Category C) (taken from Dror, 2020).

Three key aspects of a toxicology case may be affected by cognitive bias: the *selection of tests* or *case strategy*, the identification of a substance during *drug screening*, and the *interpretation* of test results. Whilst all of these processes can be influenced by cognitive biases, some specific examples are discussed here. For example, the selection of tests can be influenced by expected frequency bias [10]. If the toxicologist incorrectly bases their decisions on past experiences and assumptions about the people involved in the case then the treatment of this case is biased. During *drug screening*, for example, comparisons are made between the case sample and drug reference standards, and this (often visual) comparison can be affected by the target reference or if the analyst is given contextual information about the case [6, 9]. The *interpretation* in forensic

toxicology is often subjective, for example, it is based on the specific individual toxicologist doing the work, their own personal knowledge and experience [11] and this can create expectations that lead to confirmation bias or tunnel vision [12].

A previous self-reported survey study showed that few toxicology laboratories have a policy on cognitive bias, or use bias-minimizing procedures in the laboratory [8]. This is despite ISO 17025: 2017 (the standard to which many forensic toxicology laboratories are accredited), requiring work to be "free from bias" [13].

The question is whether contextual information can impact decision-making in forensic toxicology, just like it impacts DNA [7, 14], anthropology [15-17], blood pattern analysis [18, 19], crime scene investigation [20, 21], handwriting [22, 23], and bullet comparison [24] for a review, see Cooper and Meterko [4].

No study has empirically examined the potential for bias in forensic toxicology decision-making. This paper aims to address this gap by conducting two experiments; one looking at the effect of contextual information on the selection of tests, and the other on a decision commonly made during drug screening. Whilst previous studies have looked at analytical chemistry [9] and there has been one report of errors that have occurred in forensic toxicology casework [25], this paper is the first experimental data collection examining the potential impact of cognitive bias on forensic toxicology decision-making.

### *1.1. Immunoassay screening*

Immunoassay is used in forensic toxicology to rapidly screen biological samples for the presence of groups or 'families' of drugs e.g., benzodiazepines. Immunoassay results are *presumptive*, which means that they do not provide unequivocal evidence of the presence of a drug and any positive findings should be confirmed by another more sophisticated technique, such as gas chromatography-mass spectrometry (GC-MS) or liquid chromatography-mass spectrometry (LC-MS) [26]. The secondary technique is used firstly to confirm the positive result of the immunoassay, because immunoassays are known to suffer from false-positives [27], and secondly, if the result is a true positive, to identify the member(s) of the drug family present. Like many tests in forensic toxicology, immunoassay screening is carried out in batches e.g., multiple cases are

analysed together, sometimes with repeats of samples from each case, as well as positive and negative control samples. It is also common for the analyst carrying out the immunoassay to be different to the toxicologist reporting and interpreting the case.

Immunoassays are simple colour-change tests, and in the penultimate step of the test the intensity of the colour produced by the sample is observed and converted to a numerical value known as the absorbance (Abs) or optical density (OD). In the final step, the analyst reviews the data and uses a simple mathematical rule to determine which samples require confirmation, and which are negative. This involves comparing the Abs value from each case to the Abs value from a control sample (a biological sample spiked with a drug reference standard), known as the ‘‘cut-off’’ value. In this study, participants analysed data from a competitive enzyme-linked immunosorbent assay (ELISA), therefore if the case Abs number was lower than the cut-off Abs number the case was *presumptively positive*, if it was higher than the cut-off, the case was *negative*.

As with other forensic disciplines, methods used in forensic toxicology can produce ambiguous data, i.e., data very close to the cut-off. In this situation, if the analyst has read the context of the case, it could ‘nudge’ them into making a mathematically incorrect decision by giving them the illusion of a stronger basis for the decision than is warranted by the raw data [9].

This study consisted of two experiments. In experiment 1, the participants were given the Abs value of the cut-off and the Abs values for five different post-mortem cases, then asked to decide whether or not each case required confirmation. The Abs values given to all participants were identical, but some participants were also given potentially biasing context about each case. The other participants acted as a control group, receiving no case information.

### *1.2. Case strategy*

When a case is received by a forensic toxicology laboratory an initial decision on which tests are required must be made. These may include alcohol, common drugs of abuse (e.g., opiates, amphetamines, cannabinoids, etc.), prescription medications and some over-the-counter medications such as paracetamol. As with the immunoassay screening, these tests are usually carried out in batches. For less common substances (e.g., inhalants) one-off analyses may be required.

Depending on the jurisdiction, the customer (e.g., police officer or Pathologist) may send strict instructions detailing which tests are needed, or the decision may be made in collaboration with, or entirely by, the toxicologist. In some laboratories, cases are assigned to named toxicologists at the point of receipt, and decisions are made by the scientist who will ultimately report the case. In other laboratories, one or two toxicologists are responsible for "booking-in" or "receiving" the samples and choosing the tests. In some case types, e.g., workplace drug testing or driving under the influence, the choice of tests may be restricted by law [28] or contracts agreed in advance with the customer. Therefore, in this experiment the focus was placed on post-mortem cases where the range of tests is usually less restricted by these external factors.

For toxicologists deciding on tests, there may be an existing framework within the organisation that can guide the choice of analyses. This is most common within accredited laboratories. In other laboratories there is no standard set of screening tests, and decisions are made on an ad hoc, case-by-case, basis. In this scenario, the choice of tests is inherently subjective, and therefore can be affected by expected frequency bias [25, 29]. This occurs when the toxicologist develops expectations about drug use in people of different ages, genders and ethnicities and unconsciously (or sometimes consciously) uses that or other information, such as organisational factors [9, 30], to make decisions. Such stereotypes have been shown to bias fingerprinting [31] but not toxicology decision-making.

## 2. Methods

In this study we investigate the effect of contextual information on the analysis of data produced during an immunoassay screen for opiates, and the choice of drug tests for five post-mortem cases. Participants were all given the same data but assigned to groups with differing, or no, case context for each decision they made.

### *2.1. Study design*

The participants were third-year Forensic Science and Forensic Chemistry undergraduate students. They received training in analysing immunoassay data and determining case strategy prior to completing the tasks, which were part of the module FRS3053M Drugs of Abuse and Forensic

Toxicology taught by the first author over a 13 week period. Each experiment was carried out a week apart during timetabled classes, anonymously and in silence.

Prior to testing, we gave each potential participant (the module had 73 enrolled students) a Participant Information Sheet that detailed the tasks involved and gave them an opportunity to ask questions. Those who were willing to participate then signed an informed consent form before participating in the tasks. Consent forms were returned anonymously into a box. Demographic information for the participants was not collected (gender and age) as that would identify responses from the small number of mature students in the class. To minimize any potential influence on the decision-making process, participants were not informed of the true purpose of the experiments until after the second one was complete. At this point, participants were informed of the actual research aim, following standard ethical research practice for incomplete disclosure research methods. Participants were then given the option to withdraw their data. Fifty-eight participants completed the immunoassay task (experiment 1), and 53 participants from the same cohort completed the case strategy task (experiment 2).

*2.2. Experiment 1: Immunoassay*

In experiment 1, the participants were asked to analyse the data from an immunoassay test for opiate-type drugs (morphine, codeine, etc.). Participants were assigned randomly to either Group 1 (no context) or Group 2 (context). Participants knew the data were part of a death investigation and had come from a post-mortem blood sample. In the first step, they were required to transcribe the raw data into the ‘‘Abs’’ column of the table in Box 1 of the Appendix. In the second step they were given the cut-off Abs value (0.63) and asked to compare it to each case Abs value, decide if the case required confirmation or not, then complete the rest of the proforma (Box 1). The options were ‘‘Y’’, ‘‘N’’ or ‘‘Unsure’’. A space for comments was also provided. In this first experiment there was a mathematically correct decision for each case based on the quantification of the Abs value for the case, i.e., was it above or below the 0.63 threshold?

The correct scientific answers are given in Box 2 of the Appendix. Some previous studies into the impact of cognitive bias on decision-making in other disciplines (e.g., for fingerprint comparison [32]) have focused on borderline or ambiguous results, but casework typically encompasses both borderline and clear-cut results, so a range of Abs values were used in this study. These

represented clear positives and negatives, as well as ambiguous or close Abs values. All case scenarios were based on real cases from the experience of one of the authors, and either reinforced the mathematical decision, or opposed it (see Box 2). Participants were not given age, gender or ethnicity information about the deceased (except Case 2). Both groups were given identical raw data.

*2.3. Experiment 2: Case strategy*

In experiment 2, the participants were given five different post-mortem cases, covering a range of case types seen typically in forensic toxicology laboratories. Participants were asked to select the tests for each case, which was accompanied with a brief case history (see Table 1). In addition to the circumstances of the case, some of the participants were also given potentially biasing demographic information about the deceased's age and ethnicity. The other participants acted as a control group, receiving only the circumstances and the gender of the deceased for each case. Since in real casework some case information is almost always received with case samples, even if it is just one word (e.g., "Hanging" or "RTC"), it was decided it would be unrealistic to provide no case information at all to the control group. The circumstances of each of the cases were kept identical across all groups, this is because the circumstances of the death are task-relevant to the choice of tests. For example, in the case of a fatal road traffic crash, where the cause of death is known, the toxicologist may choose to focus on substances that are known to cause driving impairment. In this second experiment, there was no 'correct' answer, the aim was to investigate whether the demographic information (e.g., race) affected the decisions made. The circumstances were different to the five cases in experiment 1.

A framework in the form of a test request sheet was provided for selection (see Box 3 of the Appendix), but participants were also able to request one-off tests. Participants were asked to tick the box next to each test required. For drugs of abuse screening by immunoassay, more tests for different families or individual drugs (e.g., LSD) are commercially available, but the most common groups tested in forensic toxicology laboratories were used for the purposes of this experiment. "Benzos" represents diazepam or Valium® type drugs (i.e., sedatives), "amphetamines" represents stimulants such as amphetamine, ecstasy and methamphetamine, and "NPS" stands for "new psychoactive substances" and includes groups of 'designer' drugs such as synthetic cannabinoids, cathinones and fentanyls [33]. A screen for medicinal drugs is typically carried out by GC-MS, and

this detects some drugs not included in the immunoassay such as antidepressant and antipsychotics.

It should be noted that screening methods vary significantly between forensic toxicology laboratories, with some recognising the limitations of immunoassay and moving towards a broad or 'comprehensive' joint screening and confirmation approach using highly sensitive techniques such as liquid chromatography-tandem mass spectrometry (LC-MS/MS) [34] or time-of-flight mass spectrometry (TOF-MS) [35]. This move naturally reduces the number of case strategy decisions, simultaneously reducing the potential impact of expected frequency bias.

All participants were given the same case circumstances, but participants in Group 1 were only given the gender of the deceased. Those in Groups 2 and 3 were also given different combinations of age and ethnicity (see Table 1 of the Appendix). A space was available for comments should the participants wish to justify or comment on their choice of tests. Groups were assigned randomly. All case scenarios were based on real cases from the experience of one of the authors.

## 3. Results

### *3.1. Data analysis*

Worksheets were completed anonymously and collected, then all data were converted into numerical records using Microsoft Excel. For experiment 1 there were 32 participants in Group 1 and 26 participants in Group 2. For experiment 2, there were 16 participants in Group 1, 17 in Group 2, and 20 in Group 3.

### *3.2. Experiment 1*

For experiment 1, an accuracy rate was calculated based on the mathematically correct answer for each case (see Box 2). The results are shown in Figures 2 and 3 for the no-context and context groups, respectively. It can be seen from Figure 2 that even with no context there is a 6–12.5% error rate, with participants making incorrect mathematical decisions for the clear-cut cases (cases 1–3 and 5). For case 4, the Abs value (0.67) is very close to the cut-off Abs value (0.63), which led 21% of participants to state they were unsure. Although the mathematically correct answer is N for case 4, a value that close to the cut-off might be interpreted in some laboratories as 'too close

to call' or 'inconclusive' regardless of the case circumstances, therefore 'Unsure' could also be viewed as a valid answer.

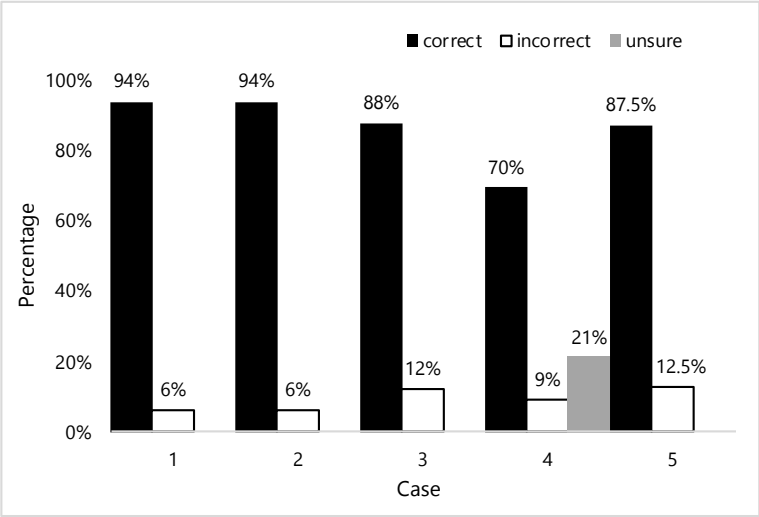



**Fig. 2.** Results for experiment 1, No context condition.

As illustrated in Figure 3 the presence of contextual information, even when reinforcing the mathematical decision indicated by the raw data, resulted in lower accuracy across all cases (error rates of 15–19% across cases 1–3 and 5). This result by itself implies that analysts making these types of decisions should be shielded from case information. For case 4, the context (Box 1), strongly suggested the deceased was a heroin user, and would therefore be expected to be positive for opiates. With this context, the percentage of mathematically correct decisions declined from 70% (*n* = 23) to 59% (*n* = 16), but of more interest was the increase in confidence the context gave the participants in the mathematically incorrect answer. Whereas 21% (*n* = 7) were unsure with no context, only 11% (*n* = 3) were unsure with the drug user context. This shows that when forensic toxicology data is ambiguous, access to contextual information will influence decisions toward an agreement with the context.

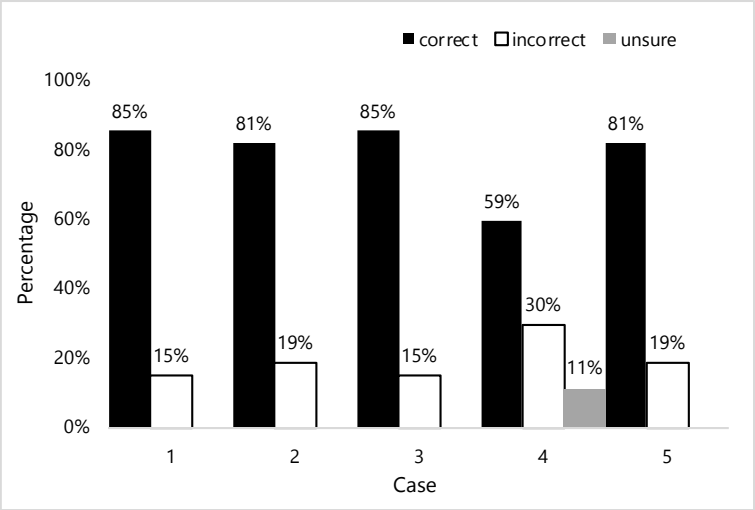
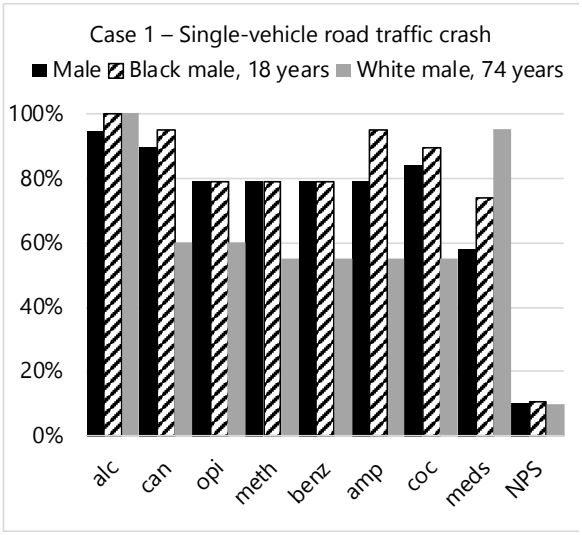


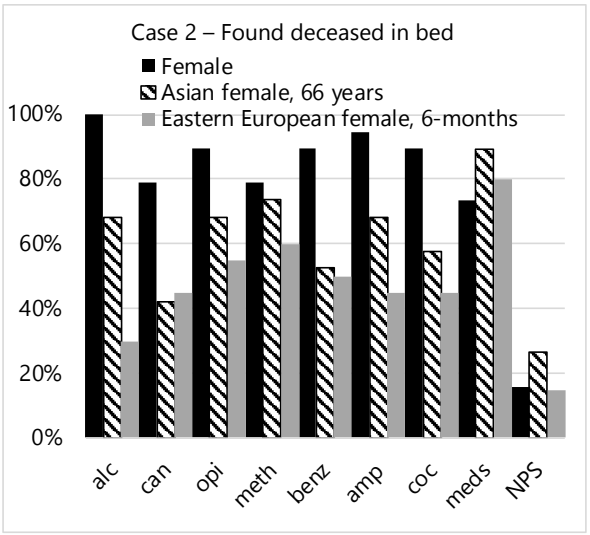

**Fig. 3.** Results for experiment 1, with biasing context condition.

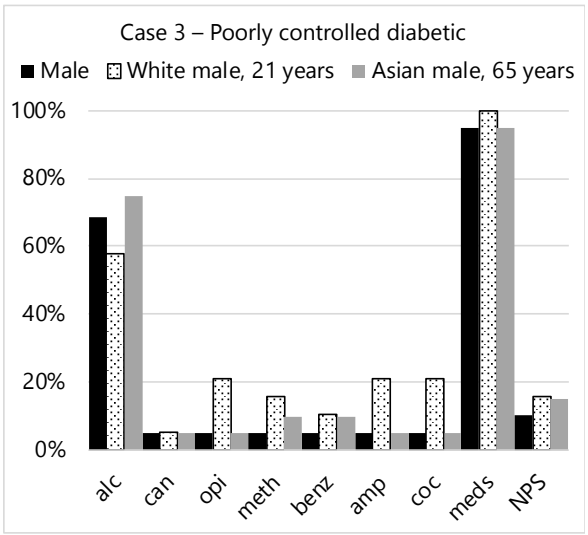
Case 2 is also of interest; the raw data clearly indicate the case is negative for opiates, but the context strongly implies morphine was given to a baby in a controversial case history. This led to the second biggest increase in error rate—from 6% (*n* = 2) to 19% (*n* = 5), although it should be noted that the numbers were overall small.

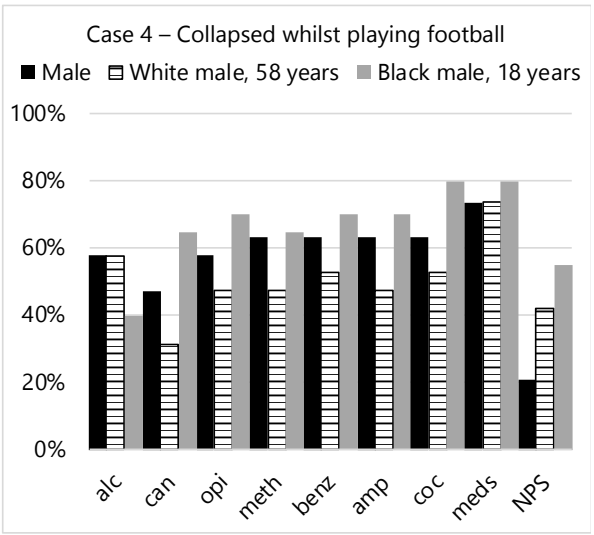
*3.3. Experiment 2*

For experiment 2, we investigated whether the demographic information (age and ethnicity) affected the case strategy decisions (and hence it was not about accuracy rates). Figure 4 shows the variation in choice of tests for each case by demographic information. The solid black bars on each graph represent the control (gender-only) group or Group 1 (in Table 2 in the Appendix), the patterned bars represent Group 2 and the grey bars represent Group 3. From Figure 4 it can be seen that the demographic information affected the choice of tests for cases with identical circumstances. For older people, medicinal drugs were a common choice of test (e.g., case 1, 74 years; case 2, 66 years), whereas for younger people, drugs of abuse by immunoassay was a more common choice of test (e.g., case 1, 18 years; case 3, 21 years; case 4, 18 years).



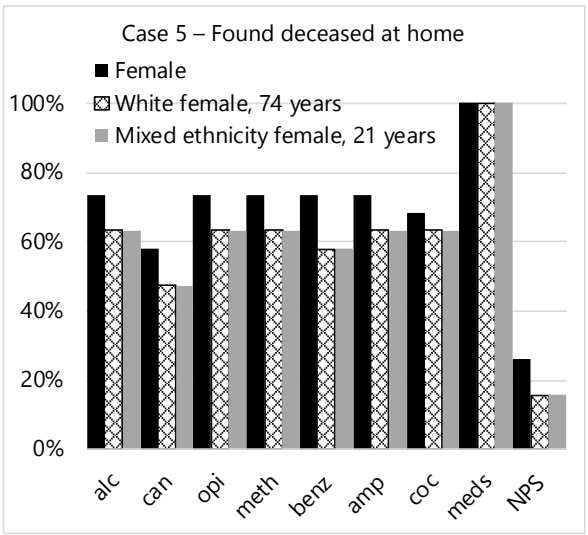




**Fig. 4.** Choice of tests for all groups. Full case circumstances are given in Table 1. The solid black bars on each graph represent Group 1, the patterned bars represent Group 2, and the grey bars represent Group 3 from Table 2 – see Appendix.

Participants were invited to comment on their choice of tests on the proforma, and the 29 comments received are given in Table 2 in the Appendix. As can be seen, comments were most frequently recorded where the deceased was at the extremes of age (a baby or a 74-year-old). Participants were also able to request specific one-off tests, and the 12 additional tests are also given in Table 2. The most common requests were related to case 3 (poorly controlled diabetes).

Although, unlikely to affect any of the case decision outcomes, of interest are two of the comments related to case 5, which touch on the intent of the deceased. The manner of death (e.g., suicide) is the domain of the Coroner, and goes beyond the expertise of the toxicologist [36], who is not responsible for integrating multiple lines of evidence (e.g., previous overdose attempts or a suicide note) [37].

## 4. Discussion

Our study aimed to investigate if contextual information could affect two key forensic toxicology decisions. Although previous findings from other disciplines have demonstrated cognitive bias, forensic toxicology is more objective, and hence may not be as susceptible to bias. Furthermore, our contextual manipulation of age and race is different from the prevailing contextual manipulation in the literature (e.g., whether the suspect confessed to the crime). Our results show that participants chose different ways to approach the next step of testing from the same data when it was presented within different contextual information.

### *4.1. Immunoassay*

In experiment 1, our results showed that the presence of case information affects the decision-making process. It caused a decline in accuracy when analysing immunoassay raw data. This was even when the context reinforced the mathematically correct decision. One explanation for this could be the overall cognitive load of the task. Although a decrease in accuracy was shown in this experiment, the point is not whether task-irrelevant information increases or decreases accuracy, but that access to the case information affects the decision-making process.

The case with the most pronounced drop in accuracy was one in which the data could be considered ‘borderline’. The context in this case also strongly opposed the mathematically correct decision. This result is consistent with previous work, where it has been highlighted that the impact

of cognitive bias is larger when the evidence is more difficult to assess [38]. As mentioned earlier, where raw data is close to a cut-off value, cases may be deemed 'inconclusive' or 'borderline'. Although the mathematically correct answer is clear, immunoassay is known to produce both false positives and false negatives [27, 39]. Given this, a valid scientific strategy could be to repeat or confirm all borderline cases (e.g., those within a certain specified ± of the cut-off value) but only if this is the pre-documented procedure in the laboratory, not post-hoc and dependent on whether or not the 'expected' or 'wanted' results were achieved. This strategy would acknowledge the inherent measurement uncertainty associated with using a single cut-off number [40], particularly in a non-quantitative test such as an immunoassay, but would not depend on the context of any particular case to make a decision.

What is more likely to currently occur however, is that the analyst refers the case to an experienced toxicologist, who reads the case circumstances in order to make the 'best' decision. There are three problems with this course of action, the first is that analysing immunoassay data is a scientific decision that should be made on the basis of consistently applied scientific criteria, and exposure to the case information compromises this scientific independence [41]. The contextual information is used to 'fill the gaps' of difficult evidence [42]. The second problem is the consequences of an unnecessary confirmation; at best this can waste time and resources, and result in unnecessary cost to the customer, at worst it can destroy a limited sample [25] and result in a case being incorrectly reported. The third problem is the consequences of a confirmation not being performed, and hence a substance that is present not being detected.

In this experiment, although opiates confirmation could be the correct decision outcome for case 4, it is important to distinguish between the decision-making process and the decision outcome [41, 43]; cognitive bias does not necessarily result in an incorrect decision outcome [14], but it sometimes leads forensic scientists to the right decision for the wrong reasons [41]. It is important to remember that case circumstances may be incomplete, inaccurate, unreliable or contain legally privileged information that would be inadmissible if presented openly in Court [44].

*4.2. Case strategy*

In experiment 2, demographic information (age and ethnicity) was shown to affect the choice of tests made for post-mortem cases with identical case circumstances. The participants were not

taught any ‘rules of thumb’ [8] when they received training in case strategy decisions, therefore the differences in choice of tests were based on their personal past experiences, assumptions or perceptions about drug use among certain age groups and/or ethnicities. These could be due to popular media, or observation of substance use in a limited group and extrapolation [45].

Although we do not advocate limiting access to contextual information at this point in a case, a consistent and documented approach to choosing tests, or a comprehensive screening method using high-resolution mass spectrometry will minimise the effect of bias on these decisions. Age cut-offs are commonly used in forensic toxicology laboratories when decisions about testing are made, to minimise workloads. If these are to be used, it is important they are based on reliable scientific evidence on drug use in certain populations rather than on the past experiences or perceptions of the toxicologist, which can be outdated and result in circular reasoning. If you only test one group for a particular drug, you will have the perception that it is only ever used by that group.

Finding bias within a decision-making process does not necessarily mean that the decisions reached in every case are incorrect. However, it is important to recognise that there is the potential for that bias to lead to incorrect decisions in some cases [46].

*4.3. Limitations*

There are some limitations to this study. Firstly, the participants were drawn from a forensic toxicology student population, which means that accuracy rates and behaviour may differ from practitioners employed in forensic toxicology laboratories who have received additional training. Although, the participants were toxicology students, the immunoassay testing is often carried out by entry-level technicians who are qualified to degree level only. Furthermore, expertise does not preclude error [47] nor immunity from bias [9]; indeed, studies in forensic science (as well as other domains) have demonstrated that practicing experts and novices alike are susceptible to bias [21]. This study was not designed to produce a discipline-wide error rate among practicing forensic toxicologists, but to investigate whether context affects the kinds of decisions routinely made in forensic toxicology laboratories. In addition, not all cases were subject to bias to the same extent, and some analysts may be more affected by context than others [48]. The latter was not explored in this study due to the anonymity required to gain ethical approval.

Secondly, although the worksheets were distributed evenly initially, some participants withdrew their consent from the study afterwards, leading to unequal numbers of responses from each group, and small changes in numbers between the different conditions. In addition, the worksheets themselves contained less context than would be received in a real case situation [8]. For experiment 2, the demographic information used only covered age and ethnicity, and there are other factors that could affect the choice of tests e.g., sexual orientation, homelessness, etc. The testing proforma used does not represent the case strategy process in all laboratories, indeed the wide variation in practices across forensic toxicology would make it difficult to find a truly representative process. However, the aim of the experiment was to determine if the demographic information affected the decision-making process, not to re-create a realistic working environment. We also recognise that case strategy is not set in stone, and can change once initial screening tests are completed, or if new information is received about a case.

Thirdly, although the participants were blind to the true nature of the study until it had finished, it is possible that some figured out the point of the experiment and changed their answers accordingly [49].

*4.4. Future work*

As mentioned previously, the participants in this study were toxicology students, and further studies should explore decisions made by practicing toxicologists. There are other aspects of forensic toxicology casework that may be affected by cognitive bias. For example, similar to Automated Fingerprint Identification Systems (AFIS) [46, 50] and e-Gate technology [51] forensic toxicologists often use 'matching' software in mass spectrometry to compare the case sample to a match from an existing library in order to attempt to identify a drug. The library spectra are created using a pure reference sample of a drug, and are compared to a response from a biological sample, producing a ranking of possible matches. Particularly in poor-quality samples, analysts are then required to undertake a subjective matching process, filtering out signals from noise for comparison [52], a process that may be affected by task-irrelevant information. The issue of how interpretation in forensic toxicology is affected by cognitive bias is a more challenging one to investigate, because interpretation is often subjective and based on the individual experience and expertise of the toxicologist, rather than accepted or standard rules.

## 5. Conclusions

In this study we have explored the effect of contextual information on two decisions commonly made in forensic toxicology laboratories. The first was the analysis of data produced during an immunoassay screen for opiates, and the second was the choice of tests for five post-mortem cases. Both decisions were affected by the context given to participants. In the case of the immunoassay data analysis, the presence of the case circumstances resulted in a decrease in accuracy of decisions, even when the context reinforced the correct mathematical decision. Based on our results that examiners analyzing case data may have biases if they are given access to case context, this, we propose that analysts making this type of decision in forensic toxicology laboratories are not given access to irrelevant contextual information. In the case strategy experiment, demographic information (age and ethnicity) affected the choice of tests for cases with identical circumstances. We therefore propose, where possible, that forensic toxicology laboratories use a consistent framework for choosing tests, and that variations or case-by-case decisions are documented and justified in casefiles.

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# Appendix

**Box 1.** Immunoassay proforma

GROUP 1

| **Case** | **Abs** | **Confirm? (Y/N/Unsure)** | **Comments** |
|---|---|---|---|
| Case 1<br>No case information | | | |
| Case 2<br>No case information | | | |
| Case 3<br>No case information | | | |
| Case<br>No case information | | | |
| Case 5<br>No case information | | | |

GROUP 2

| **Case** | **Abs** | **Confirm? (Y/N/Unsure)** | **Comments** |
|---|---|---|---|
| Case 1<br>Deceased was prescribed morphine following surgery | | | |
| Case 2<br>Deceased was a baby who had been undergoing palliative care including morphine prior to death. The parents are taking legal action against the NHS | | | |
| Case 3<br>Deceased was prescribed codeine tablets for a back injury | | | |
| Case 4<br>Deceased was a known intravenous drug user and was found close to a needle and syringe containing brown liquid | | | |
| Case 5<br>Deceased was not prescribed any medications | | | |

**Box 2.** Correct answers to experiment 1

| **Case** | **Abs** | **Confirm? (Y/N/Unsure)** | **Context** |
|---|---|---|---|
| Case 1 | 0.19 | Y | Reinforcing |
| Case 2 | 1.84 | N | Opposing |
| Case 3 | 0.11 | Y | Reinforcing |
| Case 4 | 0.67 | N | Opposing |
| Case 5 | 1.83 | N | Reinforcing |

**Box 3.** The test request sheet for experiment 2

| **Alcohol** | **Drugs of abuse by immunoassay** | **Screen for medicinal drugs** | **NPS** | **Other test (state)** |
|---|---|---|---|---|
| ☐ | ☐ Cannabis | ☐ | ☐ | |
| | ☐ Opiates | | | |
| | ☐ Methadone | | | |
| | ☐ Benzos | | | |
| | ☐ Amphetamines | | | |
| | ☐ Cocaine | | | |

Comments:

**Table 1**

The demographic information given to each group in experiment 2

| **Case circumstances** | **Group 1** | **Group 2** | **Group 3** |
|---|---|---|---|
| Case 1<br>Single-vehicle road traffic crash | Male | White male, 74 years old | Black male, 18 years old |
| Case 2<br>Found deceased in bed | Female | Eastern European female 6-month-old baby | Asian female, 66 years old |
| Case 3<br>Found deceased at home. Known to have poorly controlled diabetes | Male | Asian male, 65 years old | White male, 21 years old |
| Case 4<br>Collapsed suddenly and died whilst playing football | Male | Black male, 18 years old | White male, 58 years old |
| Case 5<br>Found deceased at home. Known previous intentional overdose with prescription medications | Female | Mixed ethnicity female, 21 years old | White female, 74 years old |

**Table 2**

Additional tests requested and comments for each case by the participants

| **Case circumstances** | **Group 1** | **Group 2** | **Group 3** |
|---|---|---|---|
| Case 1<br>Single-vehicle road traffic crash | Male | White male, 74 years old | Black male, 18 years old |
| Comments | *Can all impair driving*<br>*Because these drugs are commonly involved in driving impairments* | *Common warning for prescription drugs is do not operate heavy machinery, could narrow search down with background info*<br>*Prescribed medication may cause an impairment*<br>*Anything that might affect driving*<br>*May just be old age?*<br>*Driving impairment*<br>*Anything that could impair, but could be old age* | *Can all impair driving ability*<br>*Known to cause vehicle accidents*<br>*Impairment*<br>*Look at drugs which can cause impairment* |
| Additional tests requested | — | — | — |
| Case 2<br>Found deceased in bed | **Group 1** | **Group 2** | **Group 3** |
| | Female | Eastern European female 6-month-old baby | Asian female, 66 years old |
| Comments | *Lack of medication?* | *Could be SIDS or abuse* | *SUDEP* |

| | | | |
|---|---|---|---|
| | | *Secondary inhalation? Unlikely to be alcohol?*<br>*Overdose?*<br>*Sometimes people give a drop of alcohol in milk to make babies sleep*<br>*Have parents been giving her something? Production of drugs can release drug into the air/coat walls/floors, etc* | |
| Additional tests requested | *Solvents*<br>(1) | *Anticonvulsants*<br>(1) | — |
| Case 3<br>Found deceased at home.<br>Known to have poorly controlled diabetes | **Group 1** | **Group 2** | **Group 3** |
| | Male | Asian male, 65 years old | White male, 21 years old |
| Comments | — | *Overdose or loss of control?*<br>*Poor medicine control? Taken uppers?* | — |
| Additional tests requested | *Test for diabetes medication (insulin)? If not covered in medicinal drugs* | *Test blood sugar*<br>*Vitreous humour glucose levels*<br>*Blood sugar (glucose)*<br>*Glucose levels*<br>*Hb1c, blood glucose* | *Glucose in vitreous humour*<br>*Insulin, glycogen* |
| Case 4<br>Collapsed suddenly and died whilst playing football | **Group 1** | **Group 2** | **Group 3** |
| | Male | Black male, 18 years old | White male, 58 years old |
| Comments | — | *Young, could be drug related? Cause could be down to co-morbidities of two drugs* | *SUDEP** |
| Additional tests requested | — | *Steroids*<br>(1) | — |
| Case 5<br>Found deceased at home.<br>Known previous intentional overdose with prescription medications | **Group 1** | **Group 2** | **Group 3** |
| | Female | Mixed ethnicity female, 21 years old | White female, 74 years old |
| Comments | — | *Typical to drink before attempting overdose to increase affect*<br>*Alcohol + other drugs involved?*<br>*Possible suicide* | *Could be intentionally overdosing with medications other than prescription*<br>*Test for everything may have tried something else to overdose* |
| Additional tests requested | Solvents | — | — |

*SUDEP = sudden unexplained death in epilepsy