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Research Paper

A global survey of the attitudes and perspectives of cognitive bias in forensic anthropology

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ABSTRACT

It is now well established that decision making can be susceptible to cognitive bias in a broad range of fields, with forensic science being no exception. Previously published research has revealed a bias blind spot in forensic science where examiners do not recognise bias within their own domain. A survey of 101 forensic anthropology practitioners (n = 52) and students (n = 38) was undertaken to assess their level of awareness of cognitive bias and investigate their attitudes towards cognitive bias within forensic anthropology. The results revealed that the forensic anthropology community (~90%) had a high level of awareness of cognitive bias. Overall ~89% expressed concerns about cognitive bias in the broad discipline of forensic science, their own domain of forensic anthropology, and in the evaluative judgments they made in reconstruction activities, identifying a significant reduction in the bias blind spot. However, more than half of the participants believed that bias can be reduced by sheer force of will, and there was a lack of consensus about implementing blinding procedures or context management. These findings highlight the need to investigate empirically the feasibility of proposed mitigating strategies within the workflow of forensic anthropologists and their capabilities for increasing the transparency in decision making.

1. Introduction

Cognitive bias is a long-established phenomenon and a topic of discussion amongst the wider scientific community [1]. In broad terms, cognitive bias encompasses a series of psychological factors and mental processes such as mental shortcuts that arguably impact the process of decision-making and evaluative judgements [2–5]. An abundance of psychological literature recognises the presence of cognitive bias and its effects on human reasoning in different contexts [6–12]. Prior to 2009, there was relatively limited published research addressing the issue of cognitive bias in forensic science [13–20]. However, within the last decade, there has been an increase in the number of studies focused on the role that human perceptual and cognitive processes play in forensic science evidence interpretations [21]. As such, the impact of cognitive mechanisms on expert decision making has become a significant topic for discussion in recent years [22,23]. This has resulted in incorporating elements of cognitive and contextual bias into decision-making theories to understand decision making processes in forensic and legal investigations [24–27].

Internationally, many recent governmental reports have also called for proposed solutions and the development of rigorous protocols to guide subjective evaluation of forensic evidence [28–33]. In addition, empirical studies have presented a range of results with respect to the effects of cognitive bias in forensic science decision making [2,34,35]. Some researchers have argued that contextual bias may not necessarily lead to 'erroneous' interpretations and that contextual information may on the contrary assist forensic examiners in reaching more accurate conclusions [34,36,37]. Indeed, the challenge of conflating 'bias' and 'error' has been discussed and engaged with across the forensic science domain, with the outcome of both concepts affecting the reliability of decision making [25,38]. Humans do not process information objectively, but rather this process is characterised by our individual experiences and other contextual factors. Accordingly, cognitive bias is taken here to be a systematic deviation from rationality in judgments due to how we process, store, and retrieve information. In contrast, the term error in forensic science has often referred to systematic errors, random errors, statistical errors, or negligence of practitioners [25,39]. This paper focuses on examining the attitudes towards cognitive bias across the forensic anthropological community. There has also been a discussion regarding the complexity of defining task-relevant information.

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Arguably, 'task-relevance' may vary according to the type of forensic science analysis, as well as the different phases of the criminal investigation, and the workflow in which methods and interpretations are conducted [40,41].

Attitude surveys of forensic examiners' perception of cognitive bias can deepen an understanding of their knowledge, belief in and level of awareness of cognitive bias. As such surveys of this nature can contribute to the foundations needed for developing domain specific mitigation strategies. However, there have only been a small number of such surveys conducted [42–45]. For example, Kukucka *et al.* [44] conducted a global survey seeking to explore the beliefs and attitudes of forensic examiners across a variety of forensic science domains. The result of the survey revealed that most of the forensic examiners had extremely high confidence in the accuracy of their conclusions, showing limited understanding of cognitive bias [44]. It was also shown that years of experience was not correlated with the ratings for statements regarding the nature of bias. Similar findings were also highlighted in Hamnett and Jack [43] survey on the experience of forensic toxicologists in using contextual information during examinations. The results from their study suggested no correlation between years of experience and response to questions about contextual bias. Furthermore, a *bias blind spot* [46–49] was also noticed in some cohorts of practitioners [44], where examiners recognised bias in other experts and domains but not in their own field. The presence of a bias blind spot has also been observed amongst forensic mental health evaluators and forensic psychologists [45,50–52]. Furthermore, a majority of forensic examiners (especially those without bias training) held the opinion that bias could be mitigated through consciously setting aside their prior expectations or beliefs even though it is widely accepted in the psychological literature that bias cannot be reduced by sheer will power [44]. With regards to task-irrelevant information, a global survey by Airlie *et al.* [48] showed that over half of the examiners that took part in the survey across ten forensic domains, acknowledged that task-irrelevant information had an influence on their judgements.

Although studies in forensic anthropology and cognitive and contextual biases have been conducted [53–57], no survey to date has looked at the attitudes of professionals and students towards their perception of cognitive bias within forensic anthropology specifically. This survey was therefore designed as a follow-up study to the Kukucka *et al.* [44] and Zapf *et al.* [45] attitude surveys on cognitive bias in forensic science, specifically addressing the opinions of forensic anthropologists on the issue of cognitive bias. This study sought to establish the attitudes and beliefs of forensic anthropology professionals and students with relevant background, concerning the issue of cognitive bias. To achieve this, we sought to establish if there was a difference in the perception of the nature of cognitive bias between professionals and students as well as between bias-trained and bias-untrained practitioners; and the effects of other characteristics such as demographic, years of experience, giving testimony in court, and bias training on the perception of the nature of cognitive bias.

2. Materials and methods

2.1. Overall survey design

A questionnaire-based online survey was designed and published using Qualtrics (https://www.qualtrics.com) to collect opinion-based data. The general design of the questionnaire was adopted from Kukucka *et al.* [44] and Zapf *et al.* [45] with some modifications in order to tailor the questions to the forensic anthropological community. This survey was divided into six parts (Table 1):

This research was considered by the Departmental Ethics Committee and was deemed to not require further approval from the UCL Research Ethics Committee. No identifiable information was processed in this survey with the survey being fully anonymous in terms of participation, responses, and data collected.

Table 1
Structure of the survey.

Section	Survey Questions
Part 1: Demographics	General questions about participants' basic demographic and professional background
Part 2: Estimated Level of Confidence	Question in relation to their confidence level when establishing biological profile, with text box provided
Part 3: Scope of Bias	Questions about the scope of bias
Part 4: Nature of Bias	Rating agreements on nine statements about the nature of bias
Part 5: Cognitive Bias Training	Questions about receiving cognitive bias training, with text box provided
Part 6: Other Comments	Text box provided for participants to give further comments

2.2. Participants

Convenience sampling and snowball sampling were employed to reach as many participants as possible. Participants needed to possess professional knowledge of forensic anthropology or other relevant disciplines, (e.g. bioarchaeology, osteoarchaeology, anatomy or forensic archaeology). The survey link was sent to potential participants via general student email lists of forensic anthropology programmes, professional body general email lists, as well as distributed on social networking sites. Participants were provided with a 'Participant Information Sheet' and asked to give electronic consent prior to the survey. Participation in this survey was entirely voluntary and participants were free to withdraw their answers during the data collection period.

2.3. Demographics survey questions and estimated level of confidence (Part 1 and 2)

Participants were first asked to answer general demographic questions in addition to stating their professional and educational background, current location, as well as years of experience within forensic anthropological casework and court testimonies. The non-identifiable demographic questions were asked to obtain a further understanding of participants' backgrounds, to establish if certain demographic variables (such as level of experience) had an impact on the perception of cognitive bias within forensic anthropology. Participants were also asked to declare if they had had any bias training. In addition, they were asked to make a self-identified level of confidence (using a scale from 1-100%), with regards to establishing a biological profile. When responses were expressed as a range (e.g. 95–100%), the midpoint of the range was calculated for analysis. This question was added to the survey to look at participants' level of appreciation of cognitive bias and the perception of their own judgement as well as serve as a base of comparison with Kukucka *et al.* [44] and other studies.

2.4. Scope of bias survey questions (Part 3)

Participants were asked to answer three questions about their perception of the scope of bias in both forensic science and forensic anthropology. First, participants were asked whether they considered cognitive bias to be a cause for concern in the field of forensic science. Second, participants were asked whether they considered cognitive bias to be a cause for concern in forensic anthropology. Third, participants were asked whether they considered their own judgements to be subconsciously influenced by cognitive bias when establishing a biological profile. For each question, participants were provided with three options – 'Yes', 'No' and 'I don't know'.

2.5. Nature of bias survey questions (Part 4)

Participants were asked to read nine statements about the nature of cognitive bias in forensic anthropology and were required to express

their level of agreement about each statement using a Likert scale from one (Strongly Disagree) to seven (Strongly Agree). A rating of four (Neutral) on the Likert scale represents being neither agree nor disagree on that statement. Compared to five-point Likert scale, Seven-point Likert scale has been shown to be easier to apply, more appropriate for measuring perceived accuracy, and most importantly, more sensitive in capturing respondents' true evaluation and minimising interpolations, especially for an online survey [58,59].

2.6. Bias training survey questions (Part 5)

Participants were also presented with one semi open-ended question. They were asked to specify whether they had undergone any bias training with two response options given ('Yes' and 'No'). If participants answered 'Yes', they were then asked to provide some general details about the training they had received such as the mode of training (whether it was held online or in person) and a summary of their training course.

2.7. Statistical analysis

In total, 172 responses were collected in this survey. Data cleaning was performed before commencing analysis. Only questionnaires which were fully completed were included in the sample; whereas any incomplete or partially completed response was ruled out. This resulted in 71 responses being excluded from the sample and thus, only 101 responses were subjected to analysis. The statistical analysis was performed with STATA/MP 16.1 [60]. Percentage analysis was used to highlight some of the data and a series of logistic regressions were also undertaken to assess the attitudes of forensic anthropologists towards the nature of bias. Given that years of experience and professional status may be correlated, years of experience was chosen to be included in the model for three main reasons. First, professional status is arguably a self-identified response while years of experience could give additional insight into a practitioner's engagement in the field of forensic anthropology. Second, years of experience was easier to quantify consistently than professional status. Third, by using years of experience as an independent variable, a comparison could potentially be drawn between current and previous studies. Nine logistic models were therefore built for each statement based on the following equation:

$$\begin{aligned}\ln(Odds(Itemiaboutthenatureofbias)) &= \beta_0 + \beta_1 Age + \beta_2 Gender \\ &+ \beta_3 YearsofExperience + \beta_4 ExperienceinCourt \\ &+ \beta_5 ExperienceinTestifyinginCourt + \beta_6 AntibiasTraining\end{aligned}$$

i refers to one of the statements about the nature of bias.

3. Results

3.1. Descriptive statistics

Out of 101 participants, 77.2% were female compared to 19.8% male. This sample demonstrated a larger proportion of professionals (51.5%) compared to students (37.6%). Others (10.9%) were identified as being both academics and practitioner or student and practitioner. The vast majority (96.1%) of participants possessed either a master's degree (51.5%) or doctoral (44.6%) degree, with most of them being specialised in forensic anthropology (52.5%). Participants' years of experience in forensic anthropology casework spanned between zero and 41 years with the mean of 4.95 years (Median = 0; SD = 9.46). Most of the participants (82.2%) had not testified in court. In addition, almost all participants (94.1%) were trained to use both visual and metric

Table 2
Distribution of participant demographics and responses in relation to forensic anthropology casework and methods.

Age	Frequency	Percentage (%)
18–30	44	43.6
31–40	29	28.7
41–50	14	13.9
51–65	14	13.9
Total	101	100.0
Gender		
Female	78	77.2
Male	20	19.8
Third Gender	3	3.0
Total	101	100.0
Continent		
Asia	1	1.0
Africa	1	1.0
North America	35	34.7
Europe	60	59.4
Australia	4	4.0
Total	101	100.0
Level of Education		
Undergraduate	4	4.0
Master	52	51.5
PhD	45	44.6
Total	101	100.0
Professional Status		
Student	38	37.6
Practitioner	21	20.8
Academics	31	30.7
Other	11	10.9
Total	101	100.0
Area of Expertise		
Forensic Anthropology	53	52.5
Forensic Archaeology	5	5.0
Osteoarchaeology	37	36.6
Anatomy	2	2.0
Other	4	4.0
Total	101	100.0
Methods Trained		
Visual	4	4.0
Metric	2	2.0
Both	95	94.1
Total	101	100.0
Methods Most Often Used		
Visual	24	23.8
Metric	8	7.9
Both	69	68.3
Total	101	100.0
Given Testimony in Court		
Yes	18	17.8
No	83	82.2
Total	101	100.0
Anti-bias Training		
Yes	29	28.7
No	72	71.3
Total	101	100.0

methods in establishing a biological profile. In this cohort of participants, 28.7% (n = 29) had received bias training via different means, such as online courses, in-person lectures and independent reading. Please see further details of the breakdown of the participant demographics in Table 2.

3.2. Estimated level of confidence

In total 92 of the 101 participants reported on their level of confidence. On average, the estimated level of self-reported confidence in establishing a biological profile was 79.9% (Median = 81.25; SD = 14.17; range = 20–100%). Notably, only one participant, an academic, estimated the level of confidence to be 100% accurate.

3.3. Scope of cognitive bias

Percentage frequency distribution of each question in relation to the scope of bias is shown in Table 3. Almost all participants believed that cognitive bias was a cause for concern in forensic science (92.1%) and in forensic anthropology (90.1%). Similarly, most participants (89.1%) expressed that their own judgements could be subconsciously influenced by cognitive bias when establishing a biological profile.

Percentage analysis of responses to these three questions classified by professional status is demonstrated in Figs. 1(a)–1(c); whereas percentage analysis of responses classified by experience in bias training is presented in Figs. 1(d)–1(f). Similar findings were observed compared to the overall trend above. Regardless of their professional status or experience in bias training, both forensic anthropology experts and students in general expressed their concern about cognitive bias in both forensic science and forensic anthropology. Overall, they believed that their own judgements could be subconsciously influenced by cognitive bias.

3.4. Nature of and susceptibility to cognitive bias

Percentage frequency distribution of each statement in relation to the nature of bias is presented in Table 4. Statements 1, 2, 7, 8 and 9 regarding the susceptibility to cognitive bias are presented in Table 4. In terms of Statements 1 and 2, a plurality of the participants agreed that a forensic anthropologist's prior beliefs and expectations can affect their analysis (85.2%) and final judgement (90.1%) of a set of skeletal remains. Regarding Statements 7 and 8, 82.2% of the participants concurred that they sometimes acknowledged the presence of an expected conclusion and 78.5% of them shared that such a prior expectation can affect their conclusions. With regards to Statement 9, almost half (45.5%) of the participants agreed that forensic anthropology students are more likely to be affected by cognitive bias in their interpretation than experienced practitioners.

3.5. Mitigating cognitive bias

Statements 3, 4, 5 and 6 concerning the mitigation of cognitive bias are shown in Table 4. Sixty-two percent of participants agreed that forensic anthropologists who attempt to ignore their pre-existing beliefs and expectations are less likely to be influenced by them. Seventy percent of the participants believed that having access to irrelevant contextual information could impact their judgments in establishing a biological profile; hence, sixty-two percent of participants agreed that forensic anthropologists should be kept from irrelevant contextual information.

Table 3
Percentage (%) frequency distribution of each question about the scope of bias.

	Yes	No	I don't know
1. In your opinion, is cognitive bias a cause for concern in the forensic science as a whole?	92.1	7.9	0
2. In your opinion, is cognitive bias a cause for concern in forensic anthropology?	90.1	8.9	1.0
3. In your opinion, do you think that your own judgements could be subconsciously influenced by cognitive bias when establishing a biological profile?	89.1	10.9	0

3.6. Effects of demographics, experience, giving testimony, and bias training

The results of the nine logistic models and their associated percentages of correct classification of cases are summarised in Table 5. Overall, the logistic regression analyses demonstrated that, in combination, the independent variables (including age and gender, years of experience, whether participants had testified in court and whether they had received bias training) had no significant impact on participants' agreement on statements in relation to the nature of bias. An extra logistic regression model was run separately for Statement 2 using age as an independent variable since it was found to be a significant predictor in previous logistic regression analysis. The result of the second analysis ($X^2(2) = 2.37$, $p = 0.3065$, Pseudo R2 = 0.0444) however demonstrated that age had no significant impact on participants' agreement on Statement 2.

3.7. Narrative comments

In total, 53 participants provided narrative comments. The overall themes identified and the number of comments received in relation to questions in Part 2: Estimated Level of Confidence (n = 20 out of 101), Part 5: Cognitive Bias Training (n = 27 out of 101) and Part 6: Other Comments (n = 27 out of 101) are presented in Table 6. Bias training received by participants were grouped into six categories in Table 7. It should be noted that the calculation of the number of comments received is independent of each question. The same participants could have given comments in either one, two or all questions and thereby the number of comments received in each question was not added together.

4. Discussion

4.1. Attitudes and beliefs of cognitive bias

This survey was designed to assess the extent to which the forensic anthropology community is aware of the existence of cognitive bias and their attitudes towards cognitive bias within both forensic anthropology and forensic science. Overall, the results revealed that almost all forensic anthropology professionals and students demonstrated a high level of awareness of cognitive bias. This finding is consistent with Marten *et al.*'s cultural consensus analysis [61], which found that most of the 103 forensic anthropologists they surveyed agreed that 'awareness of cognitive bias and its potential effects' is important in order to be a 'good' forensic anthropologist. In the current study, nearly all participants believed that cognitive bias was of concern to both forensic science and forensic anthropology and agreed that their analyses and final conclusions could be subconsciously influenced by prior expectations and pre-existing beliefs. This arguably indicates a reduced prevalence of a bias blind spot [47–49] amongst forensic anthropology professionals and students in contrast to findings from previous surveys by Kukucka *et al.* [44], Zapf *et al.* [45], Neal and Brodsky [50] and Zappala *et al.* [52] in which the presence of a bias blind spot in forensic examiners were observed (e.g. biology and DNA, latent fingerprint examination, questioned document examination, toxicology and firearm/tool mark examination) and in forensic phycologists.

This change might be ascribed to the growing body of literature addressing cognitive bias in forensic anthropology in recent years. Since the initial empirical studies by Nakhaeizadeh *et al.* [54–56] studies have

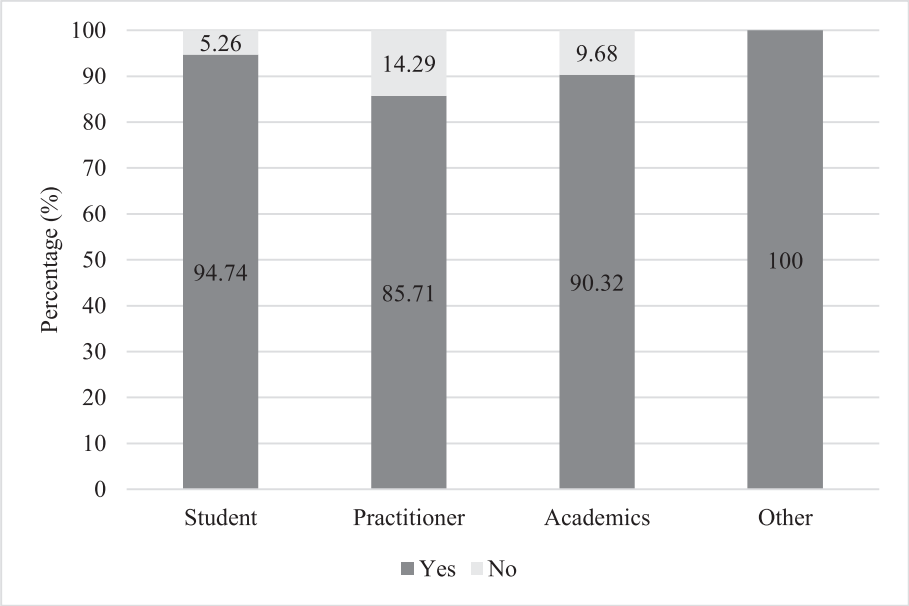

Fig. 1(a). Is cognitive bias a cause for concern in the forensic science as a whole? Distribution of participants' opinions on the issue of cognitive bias in forensic science, according to their professional status.

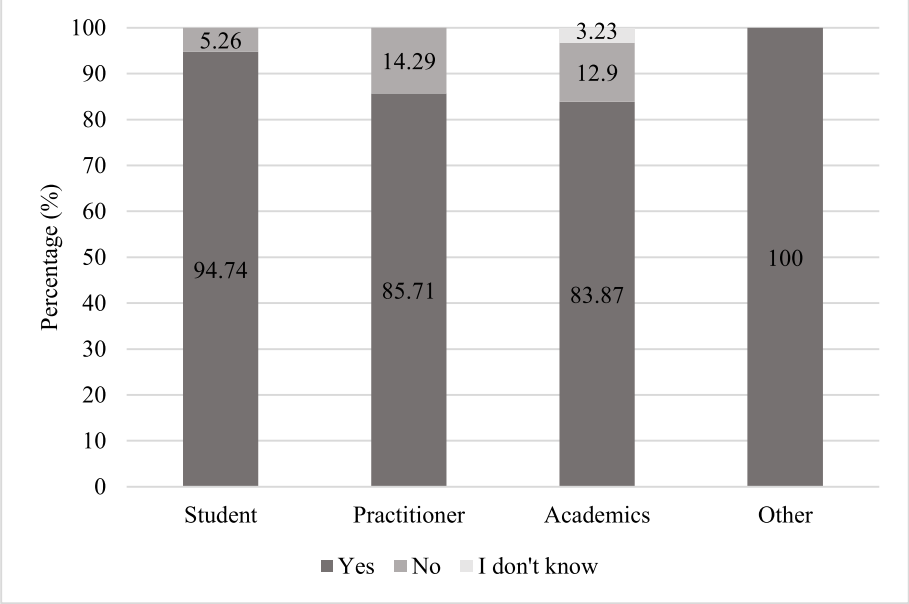

Fig. 1(b). Is cognitive bias a cause for concern in forensic anthropology? Distribution of participants' opinions on the issue of cognitive bias in forensic anthropology, according to their professional status.

now extended to consider different aspects of cognitive bias; for example, facial reconstruction [62], decomposition scoring methods [63], cognitive bias assessment within specific forensic anthropology laboratory [64] and a systematic review assessing the reliability and biasability of forensic anthropological methods [35].

Considering the similarity of sampling strategy, self-selection bias may be one possible explanation of the difference in the results between this study and Kukucka *et al.* [44] and Zapf *et al.* [45]. In terms of the participant recruitment in Kukucka *et al.* [44] and Zapf *et al.* [45], both studies recruited participants via electronic mailing list of professional forensic science organisations. Similarly in the present study, participants were recruited through general student email lists of forensic anthropology programmes, professional body and social networking sites. However, participants who received an invitation email for the current study were encouraged to introduce potential participants whom they believed to be suitable and interested in this topic by forwarding on the invitation email and survey link. The combination of convenience and snowball sampling may give rise to self-selection bias in this study. Participants who were willing to take part in the survey may be those who are more interested in or aware of the topic of cognitive bias and thereby more eager to participate, resulting in the contradicting findings observed in this study and previous surveys [65].

The difference in the distribution of age between this study and previous surveys may also, in part, explain the discrepancy in the results. In this survey, the median age range was 31 to 40; whereas the average age of participants was 44 in Kukucka *et al.* [44] and 51 in Zapf *et al.* [45]. It is possible that changes in curriculum and training practices may cause younger forensic anthropology practitioners and students being

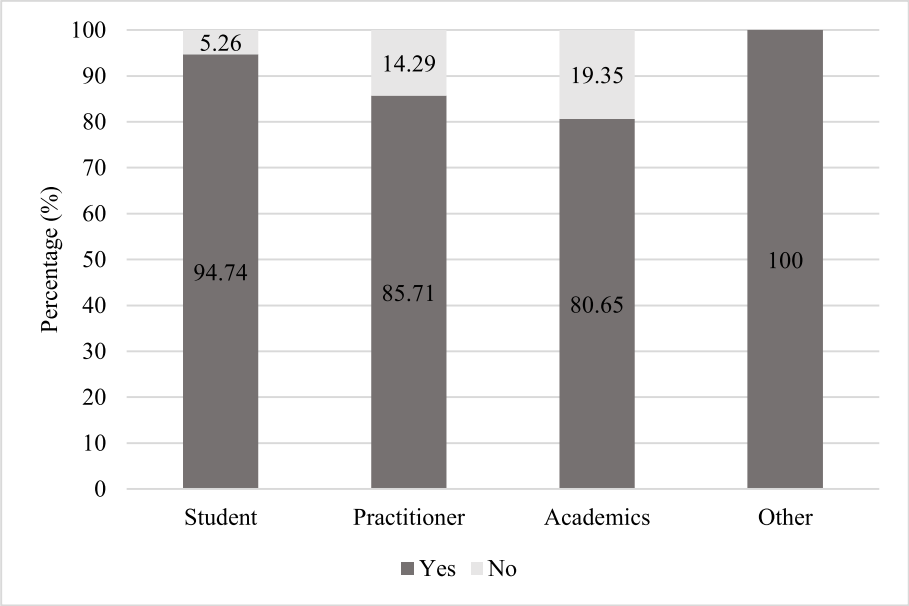

Fig. 1(c). Do you think that your own judgements could be subconsciously influenced by cognitive bias when establishing a biological profile? Distribution of participants' opinions on whether their own judgements could be subconsciously influenced by cognitive bias, according to their professional status.

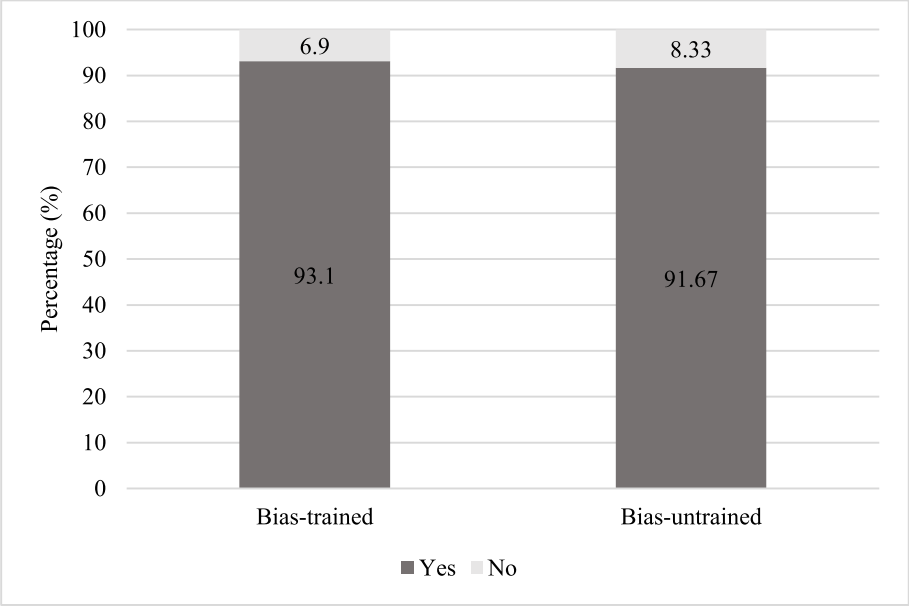

Fig. 1(d). Is cognitive bias a cause for concern in the forensic science as a whole? Distribution of participants' opinions on the issue of cognitive bias in forensic science, according as participants had received bias training.

more aware of cognitive bias [61]. Therefore, the issue of cognitive bias may potentially resonate more with younger participants. This may help explain why younger participants were more interested in and aware of cognitive bias in forensic anthropology, compared to Kukucka *et al.* [44] and Zapf *et al.* [45].

The contradicting results observed in the present study, Kukucka *et al.* [44] and Zapf *et al.* [45] may also be ascribed, in part, to the difference in the nature of disciplines. Most participants in Kukucka *et al.* [44] were from the field of biology and DNA, latent fingerprint examination, questioned document examination, toxicology and firearm/toolmark examination while all participants in Zapf *et al.* [45] were forensic mental health evaluators. The present study, Kukucka *et al.* [44] and Zapf *et al.* [45] target different forensic domains; as a result, it is reasonable that trends and findings vary according to the discipline being surveyed.

Similar to the findings of Kukucka *et al.* [44] and Zapf *et al.* [45], the majority of the participants (62.4%) in this study agreed to Statement 3 that they were less likely to be affected by pre-existing beliefs and expectations when there was a conscious endeavour to set them aside. Over half of the participants agreed to the above statement in Kukucka *et al.* 2017 [44] (71.3%) and in Zapf *et al.* [45] (87.16%). This finding indicates the existence of a certain level of misconception about what cognitive biases are amongst forensic anthropology professionals and students which may manifest itself as an '*illusion of control*' [46] and a belief that bias can be overcome by mere force of will. Some research in human cognition has argued that cognitive bias is inherent in human nature and often subconsciously stemming from a series of cognitive mechanisms and subtle psychological processes; thereby, even well-

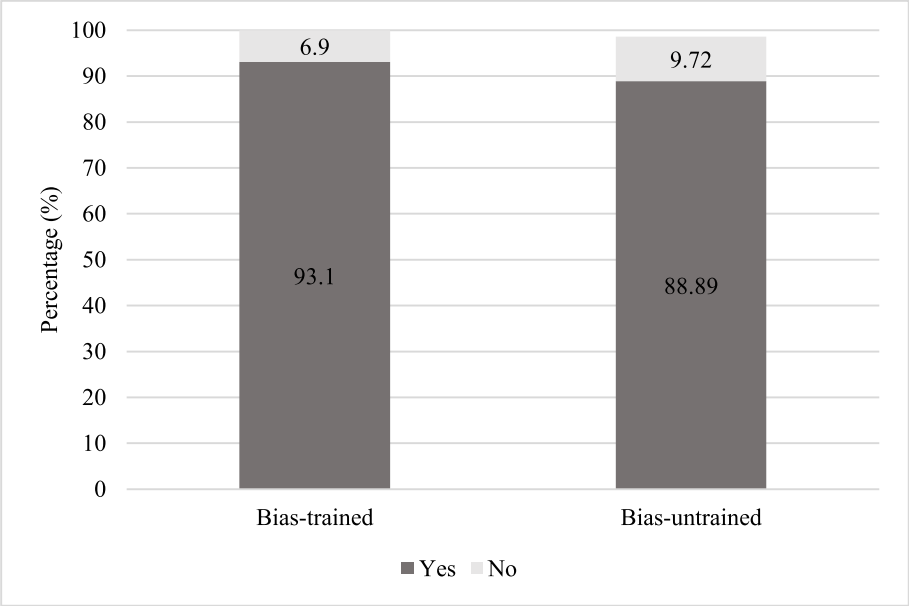

Fig. 1(e). Is cognitive bias a cause for concern in the forensic anthropology? Distribution of participants' opinions on the issue of cognitive bias in forensic anthropology, according as participants had received bias training.

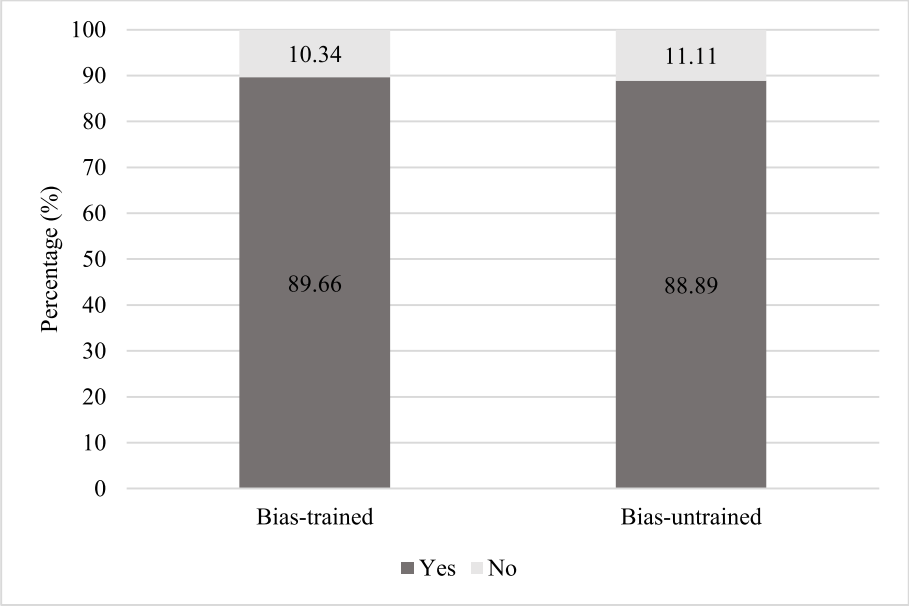

Fig. 1(f). Do you think that your own judgements could be subconsciously influenced by cognitive bias when establishing a biological profile? Distribution of participants' opinions on whether their judgements could be subconsciously influenced by cognitive bias, according as participants had received bias training.

educated, experienced and professional forensic anthropologists can be affected [44,45,66,67] as in every other domain.

Bias training and university education can help practitioners and students to develop an understanding of what cognitive biases are [68,69]. Training should also underscore the existence of different types of biases and heuristics and thereby highlight when heuristics may influence interpretations in a positive or negative way. However, systematic evaluation of bias training is also important to determine its usefulness and effectiveness and compare it to other forms of engagement on bias (such as mentorship) in order to inform the current debate about bias mitigation strategies.

The results of this study identified a lack of consensus on whether blinding procedures or context management should be implemented during a forensic anthropological examination. Although 62.6% of participants agreed with the statement that they should be shielded from irrelevant contextual information, 19.8% remained neutral with 17.8% of the participants disagreeing. This finding is similar to those of Kukucka *et al.* [44], in which half of the participants (48.8%) agreed with above statement with 20% being neutral, and Zapf *et al.* [45], where responses to the above statement were nearly evenly distributed amongst disagree, neutral and agree, showing diverging opinions on the implementation of blinding procedures across different forensic domains. It is not surprising, as up to now, there is no single universally accepted bias mitigation strategy being developed [43,70]. For example, even if blind peer review and linear sequential unmasking (LSU) of case documentation are employed, previously proposed blind testing strategies [71–76] may not be fully applicable and feasible in forensic anthropology on account of the uniqueness of methods applied to the

Table 4
Percentage (%) frequency distribution of each statement regarding the Nature of Bias. The modal response of each statement was highlighted in bold.

Statement	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
1. A forensic anthropologist's prior beliefs and expectations can affect how s/he goes about analysing a set of skeletal remains.	0	6.9	4.0	4.0	14.9	**51.5**	18.8
2. A forensic anthropologist's prior belief and expectations can affect his/her final judgement about a set of skeletal remains.	0	5.9	2.0	2.0	22.8	**49.5**	17.8
3. A forensic anthropologist who consciously endeavours to ignore his/her pre-existing beliefs and expectations is less likely to be affected by them.	1.0	10.9	7.9	17.8	25.7	**32.7**	4.0
4. Having access to irrelevant contextual information can assist forensic anthropologists in generating more accurate judgements.	9.9	**26.7**	14.9	25.7	8.9	11.9	2.0
5. Having access to irrelevant contextual information can deviate forensic anthropologists' judgements when establishing a biological profile.	0	7.9	5.0	16.8	**32.7**	31.7	5.9
6. To the extent possible, forensic anthropologists should be shielded from irrelevant contextual information.	5.0	5.9	6.9	19.8	14.9	**31.0**	16.8
7. Sometimes, forensic anthropologists are aware of what conclusion they are expected to reach.	1.0	1.0	3.0	12.9	18.8	**41.6**	21.8
8. When forensic anthropologists know what are expected to look for, it affects the conclusions they arrive.	0	5.0	2.0	14.9	25.7	**31.0**	21.8
9. Forensic anthropology students are more likely to be affected by cognitive bias in their interpretation than experienced practitioners.	0	15.8	18.8	19.8	**20.8**	18.8	5.9

Table 5
A summary of the results of the nine logistic regression models built for each statement in regard to the nature of bias.

Model	Chi-squared Test Results	Pseudo R2	Correct Classification (%)
1 In(Odds) (Statement1))	$X^2(6) = 4.21$, p = 0.6486	0.0654	86.42
2 In(Odds) (Statement2))	$X^2(6) = 7.85$, p = 0.2491	0.1492	91.57
3 In(Odds) (Statement3))	$X^2(7) = 5.93$, p = 0.5477	0.0659	76.25
4 In(Odds) (Statement4))	$X^2(7) = 4.40$, p = 0.7322	0.0480	72.97
5 In(Odds) (Statement5))	$X^2(7) = 9.49$, p = 0.2196	0.1323	87.80
6 In(Odds) (Statement6))	$X^2(7) = 5.01$, p = 0.6590	0.0591	78.48
7 In(Odds) (Statement7))	$X^2(6) = 5.72$, p = 0.4553	0.1645	91.94
8 In(Odds) (Statement8))	$X^2(7) = 6.19$, p = 0.5177	0.1289	92.77
9 In(Odds) (Statement9))	$X^2(8) = 2.67$, p = 0.9534	0.0241	60.49

Table 6
Narrative comments provided by participants in relation to Part 2: Estimated Level of Confidence, Part 5: Cognitive Bias Training and Part 6: Other Comments.

Comment left in regard to Questions	**Number of Comments Received**	**Overall Themes Identified across the Comments**
Part 2: Estimated Level of Confidence	20/101	1 Completeness and preservation status of the remains 2 Case characteristics (complexity of the case) 3 Choice of method (metric or non-metric) 4 Analysis being conducted (e.g. sex, population affinity, trauma, age-at-death)
Part 5: Cognitive Bias Training (details about the training received)	27/101	1 Online course 2 In-person course 3 Lecture from degree / university 4 Training from work 5 Independent reading 6 Combination of modes.
Part 6: Other Comments	27/101	1 Contextual information, such as recovery context and case information, to a certain extent can support the identification process, especially when dealing with trauma and pathological and/or taphonomic remains. 2 Future research should investigate the complexity of context-relevance and −irrelevance in the interpretation of skeletal remains and clarify the domain-specific definition of 'irrelevant contextual information' in forensic anthropology.

testing sample [77]. In forensic anthropological analysis, multiple methods (metric and non-metric) are being conducted on different parts of the remains in different sequences to reach an overall conclusion. This is in contrast to performing a single repeated test conducted in some other forensic disciplines. Therefore, forensic anthropologists may face the challenge of arguably being fully restricted from conducting a 'complete' blind analysis [77], as studies have shown that the order of examination on the skeleton may impact upon subsequent observations [53]. Mitigation strategies such as Linear Sequential Unmasking-Expanded (LSU-E), as a more elaborated version of LSU, have been proposed to be applicable to all forensic domains by optimising the sequence of information and hence neutralising cognitive and psychological influences [72,74]. LSU-E has however not yet been empirically tested in forensic anthropology and its effectiveness remains unknown. This might explain the split response from participants in terms of whether such context management is feasible in a forensic anthropological context. Moreover, the ambiguity as to what constitute irrelevant or relevant contextual information might hinder the implementation and acceptance of de-biasing techniques [41]. For example, four (out of 27, 14.8%) participants denoted the important role of contextual information, specifically in trauma analysis where recovery context could aid in trauma identifications (Table 6). Forensic anthropology (similarly to other forensic science fields) is context specific, which makes distinguishing between relevant and irrelevant context arguably more complex in certain cases, and often difficult to do without hindsight. For example, forensic anthropologists might need to know the context of a certain population to understand the variations in terms of skeletal morphology and expressions. Comments in relation to the issue of identifying irrelevant contextual information were the most frequently raised by those participants who left free text comments. Eight (out of 27, 29.6%) participants highlighted the complexity of context-relevance

Table 7
Distribution of modes of bias training received by participants.

Modes of Bias Training	Number of Participants
1 Online course	2
2 In-person course	6
3 Lecture from degree programme / university	6
4 Training from work	5
5 Independent reading	1
6 Combination of models	7
Total:	27

and −irrelevance and raised the question about the definition of 'irrelevant' context particularly in forensic anthropology, urging for the need for clarification in future studies.

4.2. Self-reported confidence in the interpretation of the biological profile

The mean estimate of participants' self-reported level of confidence was 79.9%, with one participant, an academic, reporting 100% confidence. This data arguably indicates a degree of 'uncertainty' in establishing biological profile. Twelve (out of 20, 60%) participants commented that the self-reported level of confidence would depend on the completeness and preservation status of the remains, case characteristics as well as the choice of method. These variables were highlighted as the most received in response to the question of self-reported level of confidence. This further shows a level of appreciation of the complexity involving in some analyses and interpretations of skeletal remains. The self-reported confidence data is contrary to Kukucka *et al.* 's [44] findings where many forensic examiners considered their own judgements to be almost flawless with 148 examiners (36.7%) reported their accuracy rate to be 100%. It is important to acknowledge response bias within self-assessed measures where there might be many reasons individuals might offer biased estimates of self-assessed behaviour, including misunderstandings of what a measurement is or what they are asked to report back on exactly [78]. In this study, a self-reported level of confidence was preferable to accuracy rates due to the difficulty in calculating the exact percentage of the rate. Unlike other forensic domains that require only a single repeated test against a known standard, a range of methods are employed by forensic anthropologists to establish a biological profile [4,77,79]. The variation of self-reported level of confidence in establishing biological profile according to different methods was the second most raised comment from participants. For example, eight participants (out of 20) made comments about their confidence differing for different aspects of the biological profile; of these, four mentioned having more confidence in sex estimation and five mentioned having less confidence in population affinity estimation. This may result in the average of the level of confidence being 'lowered' by methods used for population affinity estimation.

4.3. Perception of the scope of cognitive bias between professionals and students

Overall, the findings showed that the perception of professionals and students about the scope of cognitive bias was similar, and that professional status and demographic characteristics does not appear to predict attitudes towards the issue of cognitive bias. This is in line with Airlie *et al.* [42] survey indicating that there were no differences in responses to bias statements across all demographics. While both professionals and students generally shared the same view on the scope of bias, the student group scored a slightly higher percentage when it came to acknowledging the issue of cognitive bias. One possible explanation for this might be due to the increasing emphasis on decision making theories and the concepts of cognitive biases being included in forensic anthropological education programmes. Six (out of 27, 22.2%) participants commented that they received bias training as part of their postgraduate degree or were conducting research for their PhD in this area (Table 7). Except for general in-person course, participants received lectures in bias training from their degree programmes or university. Even though some of these courses or modules may not specifically target forensic science nor forensic anthropology, they do provide an introduction to the concept of cognitive mechanisms and biases and create opportunities to develop an independent and critical mindset that can be applied to the interpretation of skeletal evidence [80].

4.4. Years of experience and susceptibility to cognitive bias

The results of this study revealed a split response to the view of how years of experience changes susceptibility to cognitive bias. Even though 45.5% of participants concurred with the statement that forensic anthropology students, who are less experienced, are more likely to be affected by cognitive bias than experienced practitioners in their interpretation, 19.8% remained neutral with 34.7% of the participants disagreeing. Previous empirical studies in cognitive bias in forensic science and criminal investigations have shown the impact of contextual information in the decision making and interpretation of both students and experts, regardless of years of experience [81]. Furthermore, the complex role of experience and impact of cognitive bias in forensic decision making has been discussed in the literature [34,82,83]. The ongoing discussion on the complexity of years of experience in forensic decision making may arguably help explain the split response from the participants on the effect of experience and susceptibility to cognitive bias across the forensic anthropology community.

4.5. The impact of cognitive bias training

There were no differences between bias-trained and bias-untrained participants in relation to their perception of the scope of bias. Furthermore, the results of the logistic models indicated that bias training does not predict participants' attitudes towards the nature of cognitive bias. This observation is contrary to the patterns observed in previous surveys which revealed a more prominent bias blind spot in both bias-untrained forensic examiners in Kukucka *et al.* [44] and forensic mental health professionals Zapf *et al.* [45].

There is a lack of published empirical studies that have examined what may constitute effective bias training and that systematically assessed the effectiveness of such training [81]. It is also important to note that the mode of bias training received may have an influence on the level of understanding of the concept, scope, and nature of cognitive bias [43], giving rise to the difference in the level of awareness. The results from the survey showed that participants received bias training in a range of modes, such as online or in-person course, training from work and combination of modes. However, the issue relating to the role of bias training and how effective it may be in terms of enhancing the appreciation and awareness of cognitive bias remains unclear [45,81]. Follow-up interviews with bias-trained participants to understand the content, process and their feedback of training may be valuable in future research. The results of the logistic regression models also indicated that bias training (in addition to demographics, years of experience, experience of giving testimony in court) did not predict participants' opinions about the nature of cognitive bias. Similarly to Airlie *et al.* [42], no differences were noticed across demographics in response to statement about the nature of bias. It is also in accordance with Hamnett and Jack [43] that no correlation was found between years of experience and responses to questions about cognitive and contextual bias. However, in contrast to the present study, Zapf *et al.* [45] identified that years of experience did influence agreement ratings with more experienced forensic mental health evaluators tending to agree that they were less likely to be influenced by prior beliefs and expectations than new evaluators. It is however problematic to determine whether the difference in the nature of tasks undertaken across different areas in forensic

science may contribute to this discrepancy observed in this study as the task for forensic anthropologists might differ compared to others. Future studies are advised to investigate the reasons behind the responses by employing a mixed-methods approach.

4.6. Implications

The misunderstanding of the very nature of cognitive bias seems to be a common trend across studies. Gowensmith *et al.* [68] emphasised the important role of both initial education and continuing training in bias, to complement one another. Training can assist practitioners and students to develop a fuller understanding of the nature of cognitive biases and the complexity around the different theories as to how, when and why they may impact on or speed up our decision-making process. However, bias training alone cannot be the sole solution to cognitive bias. The call for transparency in the field of forensic anthropology has been raised, urging the implementation of quality assurance practices in laboratory operations [84,85] and upholding codes of ethics [86]. It therefore remains important to consider how best to increase the transparency in decision making and evaluative interpretations. For example, adopting holistic frameworks such as the conceptual model (FoRTE) [87] and the six-phased approach [25] to enhance the transparency in and reproducibility of decision making could be of value within forensic anthropology, in addition to embracing the risk-based approach [1] to systematically assess the potential risk caused by cognitive bias. The two-pronged approach, emphasised the important role of both bias training and holistic frameworks in addressing the issue of cognitive bias, would become one of the research pathways in the future.

Mixed opinions about the employment of blinding procedures or context management in forensic anthropological assessments were identified. Future research would be beneficial to understand the impact of the current proposed solutions and their applicability across different fields. The Royal Anthropological Institute [88] has stressed that forensic anthropologists must take on procedures described in Forensic Science Regulator [89] wherever possible to mitigate the potential effects of cognitive bias. Although these recommendations are valid, the forensic anthropological community has not yet fully developed a set of domain-specific blinding procedures and assessed its effectiveness across different stages of forensic anthropological process. Apart from the holistic frameworks, using eye-tracking technology could be of great value to understand the decision-making process in applying visual method in forensic anthropological interpretations. With the aid of such technology, it may shed light on the improvement of methods and the development of a set of bias mitigation strategies tailored to forensic anthropological examination [90].

4.7. Future research directions

It is acknowledged that the sample size is relatively small as well as exhibiting an overrepresentation of participants from Europe and North America. This may limit the generalisability of the results to the wider forensic anthropology community, such as those in other continents where practices and routine work may differ. Furthermore, the prevalence and nature of forensic anthropology varies across the world, and thereby affects the number of responses collected from different regions of the world. For example, regions such as North America and parts of Europe might have a more widespread presence of forensic anthropologists in comparison to other regions. This might be due to a variety of reasons with some studies highlighting the further development of forensic anthropology in countries, such as South Africa [91], India [92,93], and the Philippines [94], resulting currently in 'fewer' forensic anthropology practitioners and students from certain parts of the world. This may explain the overrepresentation of North American and European participants and the underrepresentation of forensic anthropology practitioners and students in certain regions of the world in our sample. However, future studies should make further efforts in reaching forensic anthropologists from all communities in order to represent a more diverse and inclusive view of cognitive bias globally. The utilisation of self-reports on questionnaires for the measurement of both dependent and independent variables is also an issue. Limitations related to reporting the estimated level of confidence in forensic anthropological assessment greatly depends on the given context, preservation status and completeness of the remains, the choice of the methods, the experience of the observer and whether the methods are used correctly [4]. Future studies should therefore consider using a mixed-methods strategy. Conducting a survey following with focus groups or semi-structured interviews of frontline forensic anthropologists may offer an in-depth understanding of their personal experiences in different sources of bias encountered in case work, thus building a more comprehensive picture of the cognitive, emotional and motivational sources that may affect their judgements.

Furthermore, the demographic composition of the survey sample showed 77% of participants identified as female and 70% of participants were under 40, with the median age rage being 31 to 40. However, according to recent statistics and surveys of forensic anthropologists, female forensic anthropology practitioners predominate in the United States, with 72.6% (372/512) of members of the American Academy of Forensic Sciences (AAFS) Anthropology Section being identified as female [95]. The mean age of AAFS Anthropology Section is 42 years old and the median age range reported in recent and current surveys is 30s to 40s [61,96,97]. It should be noticed that response bias may affect any opinion-based survey, as reflected in the above two aspects in the current study. Even though this survey may not represent every forensic anthropology practitioner and student in the field, the trend of participants being 'skewed' towards younger females may reflect the current distribution of the demographics within forensic anthropology in the world regions most represented in the current study.

Determining what is 'relevant' or 'irrelevant' information within forensic anthropology remains unanswered in the literature [79] and there remains a need to establish a clearer definition of these terms. While the NCFS [31] developed a working definition of task-relevant information, the variability of the task-relevance of information amongst different domains and at different stages of criminal investigation must not be overlooked [40]. Future investigations could therefore draw on experience from Gardner *et al.* [41] to conduct a survey to examine what types of information are necessary to inform the analysis and interpretation of skeletal evidence. By clarifying the definition of task-relevance, it may be possible to inform the development of domain-specific mitigation strategies and protocols to guide subjective evaluation of skeletal evidence.

5. Conclusion

This study has shown that the forensic anthropology community in general exhibited a higher level of understanding and awareness of cognitive bias compared to findings in previously published studies. The absence of a bias blind spot implies that forensic anthropology professionals and students not only recognised the existence and potential effects of cognitive bias in other forensic domains and examiners, but also within their own domain and decision making. However, most participants believed that bias can be reduced by sheer willpower, indicating that addressing the very nature of cognitive bias in future bias training and creating frameworks that enhance transparency in how decisions are reached will be valuable. In addition, the lack of agreement about the deployment of blinding procedures or context management highlights the need for conceptualising the risk–benefit relationship between cognitive bias and mitigation strategies in forensic anthropology. Future investigation will be needed to develop a domain-specific standard of relevant contextual information to put forward context management and blinding procedures in forensic anthropology casework [79].

Ethics statement

Ethics exemption was obtained from the University College London (UCL) Research Ethics Committee. Electronic consent was obtained from all participants before taking part in the survey. All participants were fully informed about the purposes of this study and how their responses would be used and stored. Participation in this survey was entirely voluntary and participants were free to withdraw their answers during the data collection period. All participants have been anonymised.

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CRediT authorship contribution statement

Kiu Nga Leung: Conceptualization, Methodology, Formal analysis, Investigation, Writing – original draft, Visualization. **Sherry Nakhaeizadeh:** Conceptualization, Methodology, Writing – review & editing. **Ruth M. Morgan:** Conceptualization, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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