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Review

The Most Common Types of Bias in a Human Bitemark Analysis

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Abstract: Given that some suspected perpetrators were wrongly convicted, a defective bitemark analysis is comparable to dentists' most crucial clinical decisions regarding assessment. Bias affects human bitemark analysis beyond the limitation of the evidence itself. The aim of this study was to explore the potential for different types of bias in bitemark analysis and the methods involved in that analysis by conducting a scoping review. Results showed that the 14 articles that explore the topic of bias in bitemark analysis were published from 2006-2022. Publications were from the USA mainly (n = 7), followed by the UK (n = 3), Australia (n = 2), New Zealand, (n = 1) and the Netherlands (n = 1). Of these publications, 36% addressed contextual bias, while 57% acknowledged cognitive bias. According to the findings, preventive measures consist of limiting the availability of unrelated data during research, employing several comparison samples for a more impartial assessment, and repeating the analysis while being blind to past findings. Nevertheless, the physical limitations of the evidence such as distortions are still strongly present.

Keywords: bites; bitemarks; human bitemarks; bias; cognitive bias; contextual bias

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1. Introduction

The field of forensic dentistry, also known as forensic odontology, is where dental evidence is used in legal proceedings. In general, forensic dentistry covers a wide range of scientific disciplines where dentistry and the judicial system intersect [1]. Keiser-Neilson defined forensic dentistry as "that branch of forensic dentistry concerned with the proper handling and examination of dental evidence and the proper evaluation and presentation of dental findings in the interest of justice" [2]. Bitemark evidence is the most controversial aspect of forensic dentistry [3]. The bitemark is described as (1) a physical alteration in a medium caused by the contact of teeth and (2) a representation pattern left in an object or tissue by the dental structures of an animal or human. Additionally, a bitemark is defined as a circular or oval-shaped wound with two symmetrical, opposite U-shaped arches that are separated at their bottoms by open spaces. Each abrasion, bruise, or laceration around an arch represents a different aspect of the contacting surface of a human tooth, such as its size, shape, arrangement, or distribution of class [4].

The Innocence Project is a planned effort being spearheaded by The Innocence Project of New York, which was set up in 1992. The Innocence Network is a coalition of non-profit legal organizations in the United States, Canada, the United Kingdom, Australia, and New Zealand committed to proving the innocence of wrongfully convicted individuals using DNA testing and the reform of criminal justice systems to prevent future injustices. The Innocence Project has worked towards the exoneration of wrongfully convicted individuals in several cases [5]. The environment in which bitemark evidence is collected and analysed is filled with irrelevant information that could influence decision-making by influencing expectation, motivation, perception, cognition, or emotion despite being irrelevant to the bitemark forensic work. This information is shared by many types of forensic science evidence [6,7]. Other potential sources of bias are more unique to bitemark analysis. As a result of the nature of crimes involving bitemarks, forensic odontologists often work in an emotionally charged atmosphere. Regardless of the interpretation method employed, the context of the bitemark is almost always presented immediately to the odontologist [6]. In other words, unlike fingerprints or shoe impressions, persistent bitemarks on skin indicate that violence has occurred; this contextual information cannot be denied. In cases involving significant trauma or injury, the forensic odontologist is likely to experience an emotional response—whether conscious or unconscious—that may play a significant role in subsequent decision-making [6,7]. Contextual bias is a subject of significant concern due to a lack of objective standards and statistics, proving alarming rates of reliability and mistake, even under "ideal" circumstances [6,8]. The President's Council of Advisory on Science and Technology (PCAST) 2016 report offers a definition of cognitive bias that describes how human perceptions and judgments can be influenced by elements that are unrelated to the decision at hand. This includes "contextual bias," in which people are shifted by unimportant background information, "confirmation bias," in which people interpret information or search for new evidence in a way that confirms their pre-existing beliefs or assumptions, and "avoidance of cognitive dissonance," in which people are hesitant to accept new information that is inconsistent with their tentative conclusion. For instance, the biomedical science community uses stringent methods, such as double blinding in clinical trials, to reduce cognitive bias [9]. To prepare, support, or enhance the way in which forensic practitioners deal with "human perception, memory, context information, expertise, decision-making, communication, experience, verification, confidence, and feedback," psychology is incorporated into their work. The goal is to improve performance and minimize errors when comparing pieces of forensic identification evidence and examining how susceptible they are [10]. The timeline for bitemark comparison in the forensic and legal literature starts with restrained professional conservatism and ends with the realization that the field's assertions must be disproven. Many assumptions and claims made by forensic dentists during bitemark comparisons lack solid data to support them. Bitemark testimony has been used in criminal prosecutions without any substantial scientific validation, estimation of mistake rates, or reliability testing. Forensic dentists may have the highest error rates of any forensic identification profession still in use [11–13]. Although there have been studies for and against the presence of bias in bitemark analysis, there are few studies that consolidate the literature in a single article. The aim of this study was to explore the potential for different types of bias in bitemark analysis and bitemark analysis methods by conducting a scoping review.

2. Materials and Methods

A scoping literature review was designed, with a focus on answering the following questions: (1) what are the types of bias present during bitemark analysis? (2) How does one avoid bias during analysis? (3) What different protocols, guidelines, investigations, or ways of examinations should be followed in bitemark analysis cases to avoid bias?

The search strategy was conducted on three academic databases, including PubMed, Scopus and Google scholar, and used a combination of key words as shown in Table 1:

Table 1. Databases and search strategies.

Database	Search Strategy
PubMed https://pubmed.ncbi.nlm.nih.gov/ (accessed on 28 May 2023)	(humans [MeSH] OR humans [Title/Abstract]) AND (Bites, Human [MeSH] OR bitemark OR "bitemark") AND (Observer Variation [MeSH] OR bias OR accuracy OR accurate OR variation OR error* OR mistake*)
Scopus https://www.scopus.com/ (accessed on 28 May 2023)	(TITLE-ABS-KEY (human*) AND TITLE-ABS-KEY (bitemark* OR "bitemark*") AND TITLE-ABS-KEY (bias, variation, OR accuracy OR accurate OR variation OR error* OR mistake* OR analysis))
Google Scholar https://scholar.google.com/ (accessed on 28 May 2023)	(bitemark OR "human bitemark") AND (cognitive bias OR contextual bias OR accuracy OR accurate OR mistake)

The inclusion criteria included academic and peer-reviewed original experimental studies solely about the effects of bias in bitemark analysis, the methods employed to avoid it and the search for better methods. It also include published scientific products circulated in diverse channels of communications, such as proceedings of scientific conferences, within the topic of interest were also included. Restrictions in terms of language (English only), time period (1990–2022), and status of publication were applied.

The exclusion criteria included books, book chapters, case reports, letters to the editor and/or editorials, and non-experimental studies.

This present structured literature review was performed following the guidelines and checklist provided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses PRISMA ScR (www.prisma-statement.org, accessed on 28 May 2023).

The selection process included the following four steps the first involved finding studies following a bibliographic search. To eliminate duplicate studies, the studies were later imported via the research information system (RIS) into EndNote X20.4.1 software for Windows. The remaining articles were then double checked using the same software by manually removing duplicates. Study exclusion based on title reading was the second stage. Exclusions were avoided at this stage in cases where there was a question as to the study's eligibility based on its title. The third phase set up study exclusion based on abstract reading so that the articles could be further screened. After reading the entire text, the fourth phase involved exclusion based on eligibility criteria. Data extraction of included articles was categorized per (1) the title of the paper, (2) the author, (3) the paper's origin, (4) the year of publication, (5) the type of study, (6) the type of bias, (7) by the paper's suggestions to reduce bias, and (8) by the good practice for bitemark analysis and were quantitatively analysed in the form of graphs.

3. Results

A total of 523 number of articles were found but 50 duplicates were removed, resulting in 473 articles. These articles were then reviewed, with 436 excluded and only 37 sought for retrieval. These 37 articles were again reviewed, and a further 23 were removed as they did not fulfil the inclusion criteria. Ultimately, only 14 articles were considered. Figure 1 shows the Prisma 2020 flow diagram, with a description of the 14 articles according to the 8 categories shown in Table 2.

Table 2. Article title, authors, year of publication, type of study, type of bias, suggestions to remove bias and good practice for bitemark analysis.

Title	Authors	Source	Origin/Year	Study Type	Type of Bias	Suggestions to Remove Bias	Good Practice for Analysis
Review of a forensic pseudoscience: Identification of criminals from bitemark patterns	C. Michael Bowers	Scopus	USA, 2019	RA	CB	No information	No information
Inconsistency in opinions of forensic odontologists when considering bitemark evidence	Reesu and Brown	Scopus	UK, 2016	S	NO	No information	Introduction of recognized system for validation or revalidation of bitemarks
Expert Disagreement in Bitemark Casework	Bowers and Pretty	Scopus	USA, 2009	ES	NO	No information	Caution must be exercised while examining the bitemark
Inquiry into the Scientific Basis for Bitemark Profiling and Arbitrary Distortion Compensation	Mary A. Bush et al.	Scopus	USA, 2010	ES	PB	No information	DNA evidence, consideration of crime scene context and timing of injury, and perpetrator identification will make bitemark evidence important in court

Table 2. *Cont.*

Title	Authors	Source	Origin/Year	Study Type	Type of Bias	Suggestions to Remove Bias	Good Practice for Analysis
Context Effects and Observer Bias—Implications for Forensic Odontology	Mark Page et al.	Scopus	Australia, 2012	RA	Conf.bias, CB, Cont. bias	The odontologist who was involved in collecting the evidence should not be involved in analysis. Limit the amount of extraneous information to forensic odontologist.	Measures should be taken to reduce potential biasing effects until there is a better understanding of the probable future path it will take
The Barriers to Achieving an Evidence Base for Bitemark Analysis	Iain A. Pretty	PubMed	UK, 2006	ES	NO	No information	Postgraduate programs in forensic training and research, replication of unique features on human skin and a better understanding of force used in bitemark are essential
Does Contextual Information Bias Bitemark Comparisons?	Osborne et al.	PubMed	New Zealand, 2014	ES	Cont. bias, EB	No information	Questions raised by this research should be addressed to gain further insight into the mechanisms that underlie the interpretation of bitemark evidence
How Cross-Examination on Subjectivity and Bias Affects Jurors' Evaluations of Forensic Science Evidence	Thompson et al.	PubMed	USA, 2019	S	Cont. bias, CB	Forensic scientists can reduce contextual bias by adopting context management procedures that shield them from exposure to contextual information that is irrelevant in judgement, jurors also appreciate the blinding procedures	Further research should examine the jurors view regarding other forms of contextual bias, using procedures like LSU to reduce the level of contextual bias
A Practical Tool for Information Management in Forensic Decisions: Using Linear Sequential Unmasking-Expanded (LSU-E) in Casework	Adele Quigley-McBride	Google Scholar	USA, 2022	RA	CB, Cont. bias	Using (LSU-E) technique helps to reduce the cognitive bias while analyzing any evidence	This research helps in the practical implementation of the LSU-E technique. More research should be undertaken to turn research-based solutions into implementable tools for forensic analysis
Cognitive Bias Research in Forensic Science	Glinda S. Cooper	Google Scholar	USA, 2019	ES	CB	No information	Future research may provide additional data for understudied disciplines, may assess analytical subjectivity in relation to bias, and may assess sample complexity as an effective modifier. Attention to study design and reporting guidelines may result in strong and comprehensively described studies
Thinking Forensics: Cognitive Science for Forensic Practitioners	Gary Edmond	Google Scholar	Australia, 2017	SR	CB, Cont. bias	No information	To better understand their processes, capabilities, and limitations, forensic practitioners should read about cognitive science and experimental psychology. They might be able to improve output and arrive at new, more efficient ways of producing goods, presenting evidence in a way that accurately reflects and communicates what is understood.

Table 2. *Cont.*

Title	Authors	Source	Origin/Year	Study Type	Type of Bias	Suggestions to Remove Bias	Good Practice for Analysis
Legal Psychologists as Experts: Guidelines for Minimizing Bias	Vredeveldt et al.	Google Scholar	Netherlands, 2022	RA	PB, CB	Reducing bias by raising awareness enables implementation of bias reducing measures, awareness on its own is not effective. People frequently suffer from the "illusion of control," thinking that willpower alone can overcome their biases and mental patterns. However, to effectively reduce bias, practical measures must be put in place.	This seems especially important in situations where experts draw vastly diverse conclusions from the same data. An examination of these issues would be extremely valuable from both a legal and scientific standpoint
Human Factors in Forensic Science: The Cognitive Mechanisms that Underlie Forensic Feature-Comparison Expertise	Growns et al.	Google Scholar	USA, 2020	RA	NO	No information	Further investigation should be undertaken regarding the human factors and cognitive mechanisms that play a role in forensic decision-making, in order to improve comparison performance and criminal justice outcomes
Cognitive Neuroscience in Forensic Science: Understanding and Utilizing the Human Element	Itiel E. Dror	Google Scholar	UK, 2015	RA	CB	No information	These developments will improve forensic science, but they will necessitate some rethinking and reevaluation of existing procedures and ideas, just like any shift. As cognitive neuroscience offers numerous insights into the human factor, it can greatly influence changes and advancements in forensic science.

Notes: RA = review article, ES = experimental study, SR = systematic review, S = survey, CB = cognitive bias, Cont. bias = contextual bias, NO = no information, PB = potential bias, Conf. Bias = confirmation bias, EB = emotional bias.

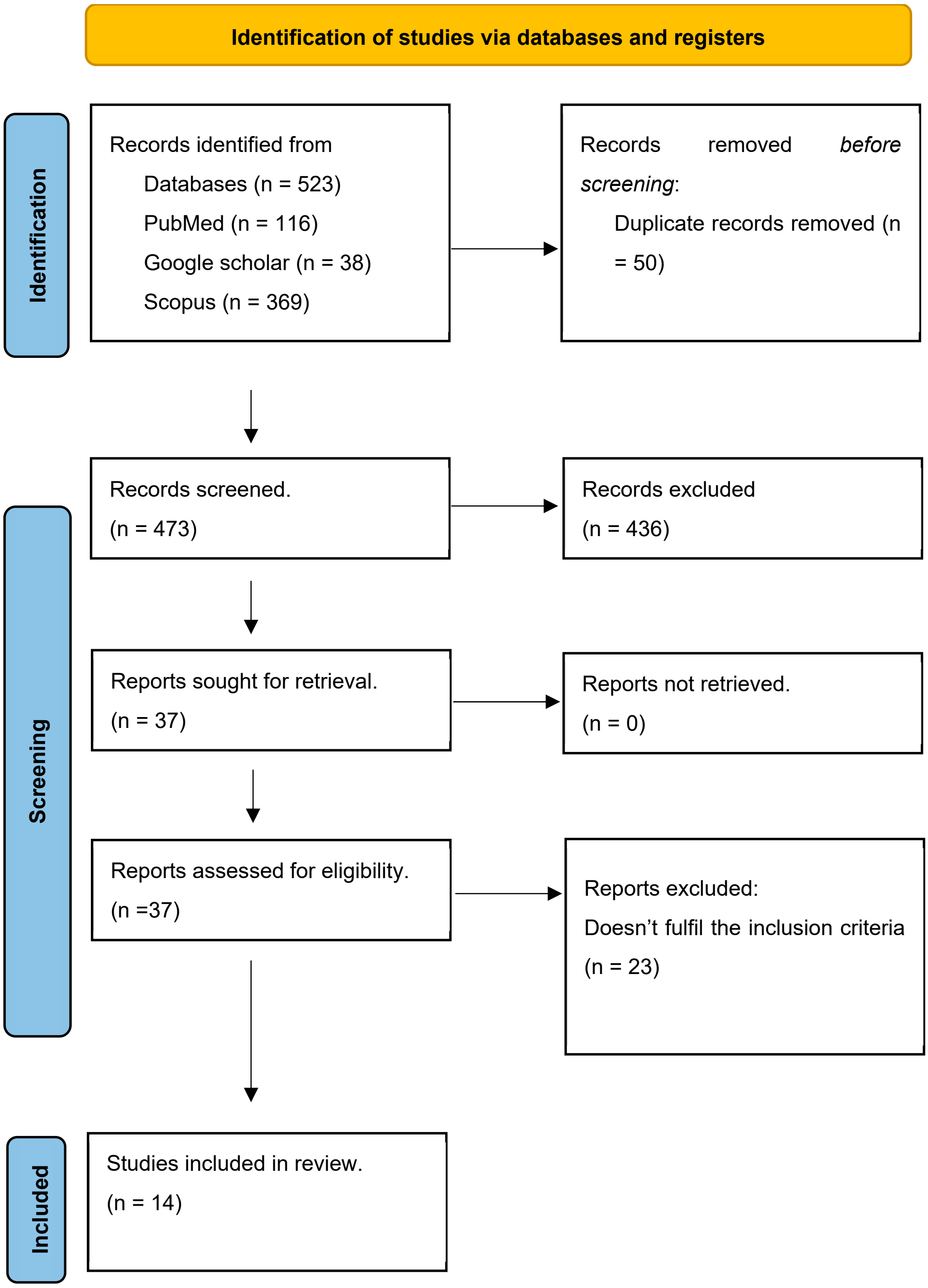

Figure 1. Prisma 2020 flow diagram for systematic review which included searches of databases only.

4. Discussion

The USA and Australia produce most articles about prejudice, with other papers coming from the UK, the Netherlands, and New Zealand as seen in Figure 2. Of the 14 research papers, 4 discuss various approaches to eliminating bias, while 13 argue that a certain methodology or method should be used, and that more research in this area should be conducted. Out of 14 articles 5 were experimental studies 7 were review articles 1 is a systematic study and 2 are the survey and a few papers suggest that a recognized system for validation or revalidation of bitemarks should be introduced [14]. Many factors are taken into consideration before making an analysis and arriving at a decision. These may include DNA evidence, the context of the crime scene, or the timing of the injury and identification of the perpetrator. The importance of bitemark evidence in court cannot be overlooked. In 2019, three papers were published in the USA highlighting the issue of bias in bitemark analysis. This was brought to light by The Innocence Project, which exposed the wrongful conviction of Roy Brown in a case that garnered a lot of attention. The project also revealed the truth about many other cases that were affected by biased decisions during bitemark analysis [15]. The year 2022 produced two articles, one from the USA and the other from the Netherlands. The scientific basis and dependability of this forensic human approach are seriously questioned when bias is examined in human bitemark analysis. In order to establish a relationship between the two people involved in a bite, bitemark analysis includes a comparison of the markings on the skin of a biting victim with the teeth of a suspected biter. However, several studies and reviews have cast doubt on the reliability and accuracy of the bitemark analysis, raising the possibility of biased judgments in court cases. Bitemark evidence has been used in several high-profile cases to support incorrect convictions, raising more concerns about the validity of this forensic method. DNA exonerations have highlighted the limitations of bitemark analysis, underscoring the necessity for a careful evaluation of its scientific foundation and the dangers of biased judgment [16].

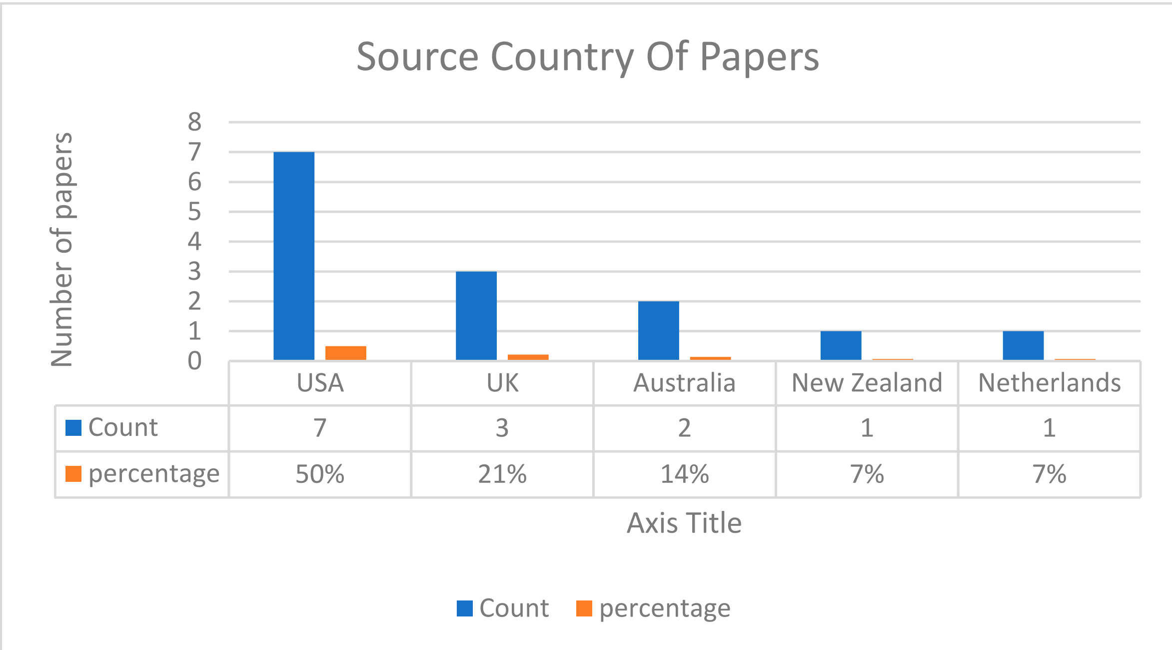

Figure 2. The source country of papers.

During the 1960s and 1970s, the identification of dental remains from deceased individuals began to advance in the UK and USA. As a result, bitemark comparison became a significant addition to their established forensic role. A landmark court case in the USA from 1975, despite being characterized as "unusual" by the testifying dentists, played a pivotal role in the widespread acceptance of bitemark evidence in all 50 US states. The concept of bitemark identification is founded on the premise that human teeth possess distinct characteristics, and that skin can accurately record the impressions of these dental markings [12].

Through the 1970s, there were no studies about human tooth shape variability and "dental uniqueness," and, since then, there have been only scattered and superficial attempts. Despite this and given that bitemark criminal case law dates from the 1980s, surprising behaviours can be observed. Dentists testifying in court and pledging loyalty to the idea of human "dental fingerprints" have validated the "uniqueness" of the claim. The lack of substantial study was not enough to discourage the defenders of bitemarks, and these "belief" statements, without supporting facts, were incorporated into bitemark identification cases that were accepted in state and federal courts across the United States [12]. The ABFO issued stricter rules in February 2016 to restrict its members use of bitemark testimony. Scientific doubts, incorrect beliefs, and the ethical and professional concerns of its members all played a role in this recent incident. The most recent set of guidelines, which were released in March 2016, limit individualization testimony in any circumstances [4].

According to a 2009 report regarding bitemarks from the National Academy of Science (NAS) in the USA, deep conversations with bitemark practitioners, bitemark researchers, and related science professionals were conducted as part of an interdisciplinary scientific collaboration in which all academic and professional research on bitemark analysis was gathered. The relevant committee was unable to find any reliable scientific data to support the reliability and validity of bitemark methods. The lack of evidence for an established scientific rationale favouring one-person over-all others was reported to the committee. This makes the categorical assertion that any choice of identity, whether it be one that is "highly probable," "possible," or "to the exclusion of all others," is not supported by science and so has the potential for error [12,17].

Potential bias in human bitemark analysis refers to the possibility that subjective assessment, personal convictions, or environmental factors may affect the inferences derived from the analysis. This bias can influence the examiner's assessment of the bitemark, perhaps resulting in inaccurate results [18].

The most important type of bias in bitemark analysis is cognitive bias (as seen in Figure 3). When someone collects, perceives, or interprets information, cognitive bias can affect how they decide to do so. For example, two competent examiners with different mindsets or working in different contexts may come to conflicting conclusions about the same evidence. The methods used, the availability of information unrelated to the job at hand, prior experience in unrelated situations, or more general factors linked to motivation, training, laboratory culture, or human decision-making have all been highlighted as potential sources of cognitive bias in earlier studies [19]. According to Dror and Kukucka there are eight sources of cognitive bias in forensic science, and these are divided into three categories. Category A is case specific and includes data, reference materials, and contextual information. Category B speaks to environment, culture and experience and consists of base rate, organizational factors, education and training. Finally, Category C refers to human nature and includes personal factors, human and cognitive factors, and brain. Psychologists have long recognized that extraneous and contextual information can have a significant impact on one's judgment. However, in regard to forensic odontology, there is currently no research available to determine how motivational and cognitive biases might affect the opinions of odontologists when analysing evidence. It seems that there are several possible sources of biased influences in the practice of bitemark analysis. While it is inevitable that some degree of bias will be present, there are several strategies that can be used to minimize its impact. These include separating the phases of data collection and analysis, restricting the contextual information accessible to the odontologist conducting the analysis, and ensuring that any unclear or subpar evidence is identified and dealt with appropriately [19,20]. There are other sources of cognitive bias, including the observer effect, which can be defined in terms of the unintended transmission of behaviour from experimenters to test subjects via a researcher's expectations. The Hawthorne effect is a term for a phenomenon that results in participants acting with more intentionality or performing better when they are aware that they are being examined. The fact that dental students often outperform regular dentists and, in some cases, forensic odontologists themselves is an interesting observation of many interobserver odontology studies [21–23]. Other sources of cognitive bias are the contrast effect and the overconfidence effect [21]. The contrast effect can be explained as a phenomenon, especially prevalent in subjective comparison work undertaken by forensic odontologists, that indicates the tendency to change a judgement standard following repeated exposure to stimuli of a given threshold. The odontologist progressively starts to 'see' the relationship between the mark and the dentition after thorough analysis, which shows the susceptibility to contrast effects. Through a "target-shifting" mechanism, the fact that such analysis is carried out alongside a reference like the suspect dentition also creates bias [21,24]. The overconfidence effect is that which is related to practitioners' tendency to overestimate their aptitude for performance, particularly when handling routine or oft-repeated activities. Eventually these become bias in the analysis [21].

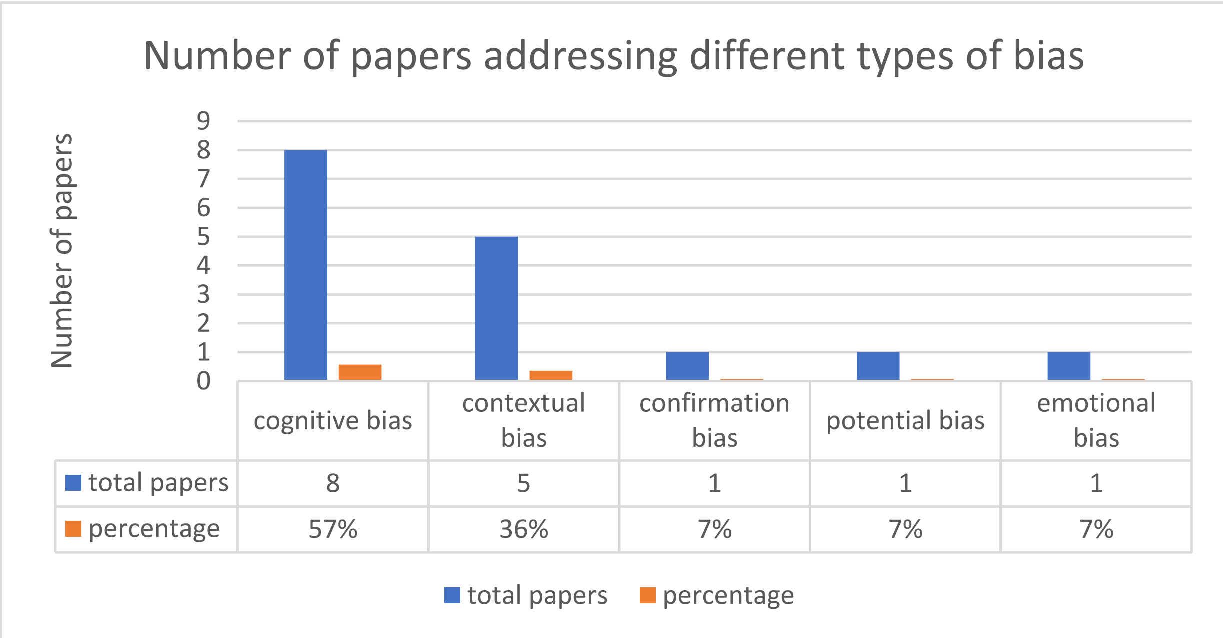

Figure 3. The number of papers addressing each type of bias.

The second most common bias during human bitemark analysis is contextual bias (as seen in Figure 3). The seven different sources of contextual bias are as follows: (1) another examiners decision about the same material, (2) explicit suggestion about what the conclusion should be or which person left the sample at the crime scene, (3) that a suspect provided a verified alibi, (4) that the suspect has confessed the crime, (5) information about the type of crime or photographs of the crime scene or that are relevant to the crime type, (6) demographic information of victim or suspect, and (7) that the examiner was allowed access to other materials or forensic evidence that they were not tasked with analysing [19,25]. There are two key reasons to believe that contextual bias may be a problem with bitemark analysis. The first is that a significant amount of emotional context is built into the evidence when a bitemark left on skin is subjected to forensic investigation. It is unlikely that all emotional context, such as the harm the perpetrator has caused, can be eliminated from crimes linked with sexual assault, child abuse, or homicide. A forensic odontologist's emotional response to the evidence, whether conscious or unconscious, could have a substantial impact on the subsequent forensic decision-making in situations when there has been significant trauma or injury [26–28]. Second, it is uncommon for bitemarks to leave clear impressions that may be easily analysed. Instead, the bite's appearance may alter over time or include bruising, swelling, and broken skin, which will produce misleading patterns [26,29,30]. One method that can be used to avoid contextual bias is to make use of a 'case manager' [31]. In certain laboratories, a "case manager" mediates between the lab examiners and the criminal investigators. The case manager consults with the investigators to decide which pieces of evidence require examination before they are given to the examiners for inspection, testing, and comparison. Due to this division of labour, the case manager can be fully informed about the case's history, while the examiners are simply provided with the information needed to carry out the desired examination or test. Once the examiners have documented their conclusions, they will eventually obtain the case's background information [32–34]. Linear sequential unmasking (LSU) was recently expanded by Dror and Kukucka into LSU-Expanded (LSU-E), allowing the framework to be used in any forensic domain and enhancing decision-making in general rather than concentrating only on reducing bias. Examiners decide in advance which pieces of information to consider and in what order under the LSU-E framework. The relevance, objectivity, and biassing power criteria are the three factors that decide these conclusions [19,20]. There is also a useful worksheet that is adaptable to any field of forensic science and can be used to implement LSU-E in lab settings. The user must first identify the data point in question (such as a suspect sample, demographic data, or other incriminating or exonerating evidence) and the information's source (such as the crime scene, an interview with the police investigator, an email from the prosecutor, or a database). After that, the user evaluates the information considering the three LSU-E criteria (biassing power, objectivity, and relevance), and rates it on a scale of one to five for each criterion [19]. Without our knowledge, contextual information can influence the choices we make. Contextual data might cause forensic professionals to make errors and even reverse their decisions. Even while forensic professionals are aware of the risks, they are unable to overcome or account for them. We often use contextual information to aid in our decision-making. Decision-making can be influenced and even improved by factors like mood, past experiences, and incidental information. Making decisions in the face of contextual information, however, can occasionally result in confirmation bias, in which we purposefully look for and interpret information in a way that is compatible with our pre-existing ideas or expectations [35–39]. According to Dror, there are five levels which contain irrelevant information for the forensic scientist or examiner: level 1 is trace evidence, level 2 is reference material, level 3 is case information, level 4 is base rate expectations, and level 5 is organizational and cultural factors [13]. Procedures for controlling the impact of context, like sequential unmasking (at a case or discipline level) or the use of blind analytic techniques, can help to lessen the issue. Contextual bias can be lessened if techniques like these are used and forensic practitioners are not exposed to extraneous (i.e., domain irrelevant) information before reviewing evidence. To the greatest extent possible, forensic professionals should be blind to irrelevant information, even though this may be challenging to achieve in practice [39].

Determining the influence of forensic evidence on court procedures depends critically on the details and jargon used in forensic testimony.

How forensic investigators should communicate their findings is a topic of continuous discussion [13]. While presenting the report in a court of justice, a forensic examiner may experience three issues. The first is disclosure, or what is reported, and how it is expressed within the forensic report. This is affected by the adversarial system within which the forensic scientist works. Second, the thoroughness of the documentation in the report is necessary for the scientific accountability and transparency of the forensic examiner's work. The effects on cognition that derive from writing a report itself comprise the third issue. To the greatest extent possible, forensic examiners should be thought of as laboratory scientists examining forensic evidence. According to this perspective, it is essential for them to focus on the science in their job and to keep it as far away from the adversarial legal system and the criminal investigation as is feasible [13]. Given the possibility of contextual biases, which we can refer to as "cognitive contamination," it is crucial that forensic examiners concentrate on the relevant scientific data, separating and blocking out irrelevant information that can bias their findings [13]. Base-rate expectations are another factor that might lead to biased forensic judgements. Such biases result from patterns that cause the brain to process information in a particular way. The employment of database search technology in forensic science is an illustration of such bias [13,40]. Feedback is necessary for the forensic odontologist, as accurate feedback is beneficial for learning in many contexts, including learning how to interpret complicated visual patterns. Receiving feedback on a variety of challenging examples increases the likelihood of strong learning that generalizes to new stimuli. Although learning can take place in the absence of feedback, it often happens more rapidly, is more robust, and has a longer shelf life when feedback is present. False feedback (the supply of misleading input) may lead to higher error rates. Learning can be hampered by the provision of incorrect selective, or unreliable feedback that is not directly tied to actual performance [39,41].

5. Conclusions

Most of the publications mentioned about cognitive bias followed by contextual bias. Careful examination of the scientific foundation for human bitemark analysis has raised serious concerns about its validity and dependability. Decisions may be biased because of scientific evidence that is insufficient for the fundamental assumptions that are made and for the potential impact of environmental influences. Any forensic odontologist might be biased at any point of analysis either consciously or subconsciously.

Researchers studying forensic decision-making and cognitive bias should go above and beyond to make sure that their theories can be applied in practice. Preventive measures consist of limiting the availability of unrelated data during research, employing several comparison samples for a more impartial assessment, and repeating the analysis while being blind to past findings.

The forensic science community is recommended to adopt an evidence-based strategy and to carry out rigorous research to address these challenges to enhance the precision and dependability of bitemark analysis and lessen the possibility of skewed judgments in court processes. Nevertheless, the physical limitations of the evidence such as distortions are still strongly present.

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