

Between Forensic Certainty And Legal Sufficiency: A Critical Analysis Of Latent Fingerprint Identification Evidence Under Indian Law

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ABSTRACT

This paper examines whether the certainty conveyed by latent fingerprint identification evidence in Indian criminal trials is warranted by the underlying forensic science. Drawing together black-box accuracy studies, cognitive-bias research, and the constitutional and statutory framework governing expert opinion in India, the paper argues that Indian evidentiary law's admissibility threshold is deliberately undemanding, relying on post-admission judicial weighing rather than a scientific validity gate. The forensic science, in turn, supports only a qualified, non-zero-error statement of correspondence, not the categorical claim of individual source identification typically communicated to fact-finders. Reviewing four thematic strands of the scientific literature and five illustrative Indian judgments, the paper identifies contextual bias and the gap between foundational and applied validity as the limitations that most substantially affect the evidentiary meaning of a fingerprint match, and identifies the absence of India-specific, casework-linked proficiency data as a significant regulatory gap. The analysis further finds that a leading Indian authority on expert-opinion weight itself contains dicta that overstate fingerprint certainty. The paper proposes that Indian evidentiary practice should retain fingerprint opinion evidence as admissible and ordinarily corroborative, while mandating qualified reporting language and published domestic validation data, so that the statutory right to examine an expert's grounds becomes meaningful rather than symbolic.

Keywords: Latent fingerprint identification; ACE-V; forensic evidence; expert opinion; Bharatiya Sakshya Adhiniyam 2023; cognitive bias.

INTRODUCTION

Latent fingerprint comparison is one of the oldest forms of individualisation evidence received in Indian criminal trials, and it continues to carry a persuasive force in court that is rarely subjected to the level of scrutiny applied to newer techniques such as DNA profiling. The method, formalised as Analysis, Comparison, Evaluation and Verification (ACE-V), is often presented to fact-finders as a mechanical, feature-driven process yielding a categorical conclusion. Two decades of empirical research on examiner accuracy, reproducibility and cognitive bias complicate that presentation considerably, while Indian evidentiary law had, until 2023, absorbed fingerprint opinion evidence through provisions inherited largely unchanged from the Indian Evidence Act, 1872.

This paper asks whether the confidence with which fingerprint identification evidence is typically received in Indian courts is proportionate to what the underlying science can support, and, if not, what specifically accounts for the gap. The research question addressed is: to what extent does Indian evidentiary law's treatment of latent fingerprint identification align with the level of certainty the underlying forensic science is able to support?

The paper proceeds thematically rather than chronologically. The Results and Discussion section first synthesises the scientific literature on accuracy, reproducibility, bias and terminology; it then sets out the constitutional and statutory framework together with the judicial treatment of fingerprint opinion evidence in India; it offers a critical analysis of where the resulting gap is most consequential; and it proposes measures addressing the regulatory gap

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identified. The paper then acknowledges the limitations of the present analysis before concluding.

MATERIALS AND METHODS

This is a doctrinal, literature-based legal research paper rather than an empirical study, and its "materials" are accordingly textual. Two bodies of material were reviewed and synthesised. First, peer-reviewed empirical literature on latent fingerprint examiner accuracy, reproducibility and cognitive bias was reviewed, comprising black-box accuracy studies, a national scientific-review-body report, a presidential science-advisory report, and methodological and doctrinal critiques of individualisation claims. Second, the relevant constitutional provision, the applicable statutory provisions under the Bharatiya Sakshya Adhiniyam 2023, the Bharatiya Nagarik Suraksha Sanhita 2023 and the Identification of Prisoners Act 1920, and five illustrative judgments of the Supreme Court of India bearing on the compulsion, admissibility and evidentiary weight of fingerprint opinion evidence were analysed doctrinally.

Sources were selected for thematic relevance to the research question rather than through an exhaustive systematic database search, and the five judgments discussed are illustrative rather than a comprehensive doctrinal survey. Every citation and every certainty-bearing term used in the manuscript (for example "proves", "conclusive", "unique", "confirms", "establishes") was independently checked against the underlying primary source prior to finalisation, so that the language of the paper itself is calibrated to the strength of the evidence it describes.

RESULTS AND DISCUSSION

Accuracy and error rates

The first proposition examined in the literature is that latent fingerprint examiners can distinguish true matches from non-matches at a low error rate. Ulery, Hicklin, Buscaglia and Roberts ^[1] reported a false-positive rate of approximately 0.1% and a false-negative rate of approximately 7.5% across 169 examiners in a controlled black-box study, a pattern echoed by Pacheco, Cerchiai and Stoiloff ^[2], who likewise found that both error rates rise as print quality declines. These figures are frequently invoked

to vindicate the discipline's reliability, and the false-positive rate in particular is genuinely low under the conditions tested. However, the false-negative rate is an order of magnitude higher and more variable, and both figures describe performance under study conditions using curated print sets, not the full range of quality and difficulty found in casework. Because Indian courts routinely receive fingerprint evidence without reference to any stated error rate, the undemanding admissibility standard in Indian law discussed below means this qualification rarely reaches the fact-finder.

Individualisation, foundational validity and validity as applied

A closely related proposition is that fingerprints are unique to the individual, supporting source individualisation. The National Research Council ^[3] found that, apart from nuclear DNA typing, no forensic discipline had been rigorously shown to reliably connect evidence to one specific source, and treated individualisation claims as scientifically unsupported; Kaye ^[4] separately argues that mathematical uniqueness reasoning does not by itself justify a zero-error individualisation claim. This is the sharpest point of scientific disagreement in the literature: it is not a dispute over whether examiners can distinguish matches from non-matches, which the black-box data support, but over whether that ability licenses the much stronger population-level uniqueness claim underlying courtroom "identification" testimony. The observed pattern correspondence is consistent with a very low, but not necessarily zero, probability of coincidental similarity, a distinction the President's Council of Advisors on Science and Technology ^[5] later formalised as the difference between "foundational validity" and "validity as applied" in a specific laboratory or case. This distinction is central to the research question because, as discussed below, Indian law's admissibility filter tests neither.

Reproducibility

A third proposition is that examiner conclusions are repeatable and reproducible. Ulery, Hicklin, Buscaglia and Roberts ^[6] retested 72 examiners approximately seven months after their original decisions and found imperfect self-consistency, with reproducibility between different examiners

consistently lower than one examiner's repeatability with their own earlier decision. This indicates that some of the field's apparent consistency reflects shared training rather than an objective feature of the print itself, although disagreement between examiners may partly reflect genuine ambiguity in particular prints rather than examiner error. Reproducibility limitations bear directly on the "grounds" that Indian law permits parties to examine, yet that examination is only meaningful where comparative reproducibility data exist for the laboratory in question.

Contextual bias

A fourth proposition holds that fingerprint comparison is an objective, feature-driven process. Dror, Charlton and Péron^[7] found that most of five experienced examiners reversed their own earlier identification decisions once given biasing case context, despite the underlying prints being unchanged. This finding complicates the assumption that sufficiency judgements are shaped purely by the print's physical features; extraneous case information measurably altered conclusions in this study, although the small sample size limits how far the finding can be generalised in isolation. Contextual bias is procedurally addressable through blind verification, yet neither Indian statute nor reported practice appears to mandate it, leaving this qualification largely unmanaged in domestic casework.

Terminology

A fifth, terminological proposition is that fingerprint evidence can support a categorical statement of "identification" in court. Cole^[8] documents the shift in professional vocabulary from "individualisation" to "identification" without a corresponding change in the underlying certainty claimed; Mnookin^[9] argues that fingerprint evidence should not withstand a rigorous validity test given the historical absence of proficiency testing and bias research, and that claims of certainty should be scaled back accordingly; Neumann, Evett and Skerrett^[10] propose a statistical, likelihood-ratio expression as a more calibrated alternative to categorical language. The existence of this reform proposal signals disagreement within the mainstream forensic community itself about whether categorical language should be retained at all, even though PCAST^[5] found foundational validity support from black-box studies while cautioning that validity

as applied in individual laboratories and cases remains largely untested.

Constitutional and statutory framework

Indian law permits the compulsion and comparison of specimen fingerprint impressions without infringing the constitutional privilege against self-incrimination. In *State of Bombay v. Kathi Kalu Oghad*^[12], an eleven-judge bench, by an 8-3 majority, held that directing an accused to give specimen finger, palm or foot impressions is "material" rather than "testimonial" evidence and therefore falls outside Article 20(3) of the Constitution^[11]; *Shankaria v. State of Rajasthan*^[13] further held that a police officer is competent under the Identification of Prisoners Act, 1920^[14] to take such specimens without a prior magistrate's order. Together these judgments supply the constitutional and procedural machinery that makes fingerprint comparison possible as an investigative tool in India, although neither judgment addresses the separate question of how reliable a resulting match opinion is; they settle only that specimens may lawfully be taken and compared.

The admissibility of an examiner's resulting opinion is governed by a comparatively undemanding statutory threshold. The *Bharatiya Sakshya Adhiniyam*, 2023, section 39(1)^[15] (replacing section 45 of the Indian Evidence Act, 1872) makes the opinion of a person "specially skilled" in fingerprint identification a relevant fact, while section 45^[15] (replacing section 51) makes the grounds of that opinion equally relevant and open to examination; the *Bharatiya Nagarik Suraksha Sanhita*, 2023, section 329^[16] permits a notified Government scientific expert's report, including from the Director of the Finger Print Bureau, to be used without personal appearance, subject to the court's discretion to summon the expert. This structure does not require any stated error rate or validation threshold before an opinion is admitted; it instead relies on cross-examination on disclosed grounds, and on judicial discretion to compel live testimony, to perform the scrutiny that admission itself does not. That reliance is only as effective as the willingness and capacity of counsel or the court to exercise it.

Judicial treatment of fingerprint opinion evidence

Indian courts have declined to treat fingerprint opinion evidence as automatically conclusive, instead calibrating the corroboration required to the strength of the examiner's reasoning. *Murari Lal v. State of Madhya Pradesh* ^[17] held that an expert witness is not an accomplice and that corroboration need not be invariably insisted upon, but that the degree of corroboration required is a question of fact depending on how convincing and internally consistent the expert's reasoning is; this general standard was applied to a handwriting expert's report in *C. Kamalakkannan v. State of Tamil Nadu* ^[18], where the Court held that a conviction could not stand where the very document said to bear the disputed mark was not proved and exhibited at trial. This doctrine functions as a partial, *ex post* substitute for the *ex ante* validity threshold the admissibility rule does not impose, but it operates only in cases that are actually litigated with sufficient rigour to expose weaknesses in the underlying reasoning or evidentiary chain. *Mohd. Aman v. State of Rajasthan* ^[19] illustrates the point concretely: the Supreme Court there set aside a conviction resting on a fingerprint match because of an unexhibited exhibit, unexplained delay, and repeated custodial specimen-taking outside a magistrate's supervision, grounds unrelated to the examiner's competence, showing that Indian law's principal safeguard against overstated fingerprint evidence currently operates through procedural chain-of-custody scrutiny rather than through scientific validity review.

Critical analysis

Not every limitation identified above affects the evidentiary meaning of a fingerprint conclusion equally, and documented error does not make the discipline unreliable, just as long professional and courtroom use does not mean error has been eliminated. Two limitations are, on the present analysis, substantial. The first is the gap between foundational and applied validity ^[5]: because black-box accuracy figures such as those reported by Ulery et al. ^[1] describe aggregate performance under study conditions, they cannot, without further data, be treated as a statement about the accuracy of a specific Indian laboratory, examiner or case. No procedural safeguard within the ACE-V method itself closes this gap; it can only be closed by publishing casework-linked proficiency data, which does not appear to exist

for Indian Finger Print Bureaux. The second is contextual bias at the comparison and evaluation stage ^[7], which is significant precisely because it is not confined to poor-quality prints or inexperienced examiners; it can move an otherwise sound conclusion in either direction, and neither the *Bharatiya Sakshya Adhiniyam* nor reported Indian laboratory practice appears to mandate the blind or sequential-unmasking protocols that would manage it.

By contrast, chain-of-custody defects, as *Mohd. Aman* ^[19] demonstrates, are capable of being caught and are treated seriously by appellate courts once raised, and corroboration doctrine under *Murari Lal* ^[17] and *C. Kamalakkannan* ^[18] likewise provides a genuine, if case-dependent, check on categorical overstatement. The distinction is one of reach rather than existence: chain-of-custody and corroboration safeguards are triggered by active litigation of a specific case, while the applied-validity and contextual-bias limitations are structural, affecting every fingerprint opinion offered in Indian courts regardless of whether that particular case happens to be well defended.

A further point deserves emphasis because it strengthens rather than weakens the paper's argument. *Murari Lal* ^[17] is the Indian authority most often relied upon, including in this paper, for the proposition that expert opinion should be weighed rather than accepted categorically. Yet the judgment itself contains a passage asserting that the science of fingerprint identification has attained near perfection and that the risk of an incorrect opinion is practically non-existent, language considerably stronger than the false-negative rate of roughly 7.5% reported by Ulery et al. ^[1], or the National Research Council's ^[3] refusal to treat any friction-ridge discipline as rigorously validated for individualisation. This is not a reason to discount *Murari Lal*'s holding on corroboration, which remains sound and is not the proposition in which that language appears; it is, however, a concrete illustration of the paper's central claim, showing that even a judgment cited for judicial caution can itself repeat the overstated certainty that the scientific literature calls into question.

Recommendations

The central original contribution of this paper is to identify, and propose a response to, a specific

regulatory gap: the absence of India-specific, casework-linked validity and proficiency data against which the grounds-examination right in section 45 of the Bharatiya Sakshya Adhiniyam can actually be tested. Every accuracy figure presently available to Indian courts and counsel is imported from American studies conducted under different training, accreditation and proficiency-testing regimes. Three linked measures are proposed. First, Finger Print Bureaux operating under state forensic science directorates should be required to participate in periodic, blind, casework-representative proficiency testing, with aggregate results published rather than held internally. Second, laboratory reports should be required to use calibrated, qualified language, for example expressing the strength of correspondence rather than an unqualified "identification", bringing Indian reporting practice into closer alignment with the likelihood-ratio approach proposed by Neumann, Evett and Skerrett ^[10]. Third, courts exercising the discretion conferred by section 329 of the Bharatiya Nagarik Suraksha Sanhita ^[16] to dispense with an expert's personal appearance should treat the absence of published validation data for that laboratory as a factor weighing against dispensing with live examination. None of these measures requires legislative amendment; each operationalises scrutiny that section 45 already contemplates but that currently lacks the empirical material to be exercised meaningfully.

Limitations

This paper is a doctrinal and literature-based analysis rather than an empirical study, and several limitations follow. It relies on secondary black-box and cognitive-bias research conducted outside India, in the absence of any located published Indian equivalent; whether Indian Finger Print Bureaux replicate, diverge from, or fall outside the range of performance reported in that literature is unverified rather than established. It examines a necessarily selective set of five Indian judgments rather than a comprehensive doctrinal survey, and later appellate or High Court decisions not located in the course of this research may qualify the picture presented. The paper addresses latent fingerprint comparison specifically; its critical framework, while likely transferable, has not been tested against other Indian forensic

disciplines such as ballistics or questioned-document examination.

CONCLUSION

Indian evidentiary law is not wrong to admit latent fingerprint opinion evidence, nor to treat it, through the Murari Lal ^[17] and Kamalakkannan ^[18] line of authority, as ordinarily corroborative rather than automatically conclusive; that structure is broadly defensible against the scientific literature reviewed here. What the science does not support is the categorical certainty that "identification" language continues to convey by default, certainty that, as this paper's analysis found, can surface even in the judicial dicta relied upon to justify caution, and what Indian legal practice currently lacks is the domestic validation infrastructure needed to make the statutory right to examine an expert's grounds anything more than a formal entitlement. The gap identified is therefore not primarily a gap in the law's structure but in the empirical material available for that structure to operate on. Closing it, through published, casework-linked proficiency data, calibrated reporting language, and more deliberate use of existing judicial discretion, would bring the certainty Indian courts receive from fingerprint evidence closer to the certainty the underlying science is actually able to provide.

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