CREATING REASONABLE DOUBT IN FINGERPRINT IDENTIFICATION CASES: SUBSTANTIVE AND METHODOLOGICAL REBUTTALS BY DEFENSE EXPERTS

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This work was partially funded by the Center for Statistics and Applications in Forensic Evidence (CSAFE) through Cooperative Agreement 70NANB15H176 between NIST and Iowa State University, which includes activities carried out at Carnegie Mellon University, University of California Irvine, and University of Virginia.

The authors have no conflicts of interest with respect to their authorship or the publication of this article.

All materials and data connected with this research are publicly available at https://osf.io/hxr3g/.

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Abstract

Prior research has examined a variety of reforms aimed at ensuring that jurors have a proper understanding of fingerprint evidence, finding mixed results. The present study, recruiting a large national sample of 1,716 mock jurors, using Qualtrics, examined whether three types of rebuttal testimony can create doubt about the validity of a fingerprint identification made by the prosecution's expert: (a) a methodological rebuttal explaining the risk of error in the fingerprint-comparison process; (b) a substantive rebuttal concluding the fingerprint comparison was inconclusive because the latent fingerprint was not suitable for use; and (c) a substantive rebuttal excluding the defendant as the source of the latent fingerprint. We also examined whether the prosecution can inoculate its expert from the effects of these rebuttals by pre-emptively refuting criticisms of fingerprint comparisons. All rebuttals significantly reduced perceptions of guilt, but the substantive rebuttals proved most effective. Efforts to inoculate against rebuttal testimony did not succeed; however, persons more concerned about false acquittals than false convictions were less influenced by the rebuttal testimony. The present study demonstrates that waging a battle of fingerprint experts effectively conveys information about the limits of fingerprint identifications and supports awarding funds to indigent defendants to retain their own experts to not only explain but also substantively scrutinize the government's fingerprint evidence.

Keywords

Forensic science, fingerprint evidence, juror decision-making, expert testimony, battle of experts, inoculation

I. Introduction

In the eyes of the public, fingerprint evidence linking a defendant to the scene of a crime provides extremely compelling proof of the defendant's guilt (Cherry, Imwinkelried & Schenk, 2011; Garrett & Mitchell, 2013, 2016). In fact, the general public places as much confidence in fingerprint-based identifications as DNA-based identifications (Martire et al., 2019). The persuasive power of fingerprint evidence derives from two common beliefs: (a) the belief that each individual's fingerprints uniquely identify that person, and (b) the belief that the process of linking latent fingerprints from a crime scene to an individual's fingerprints is nearly infallible (Garrett & Mitchell, 2013, 2016; Mitchell & Garrett, 2019). Given these premises, if a fingerprint examiner testifies that a particular defendant was likely the source of fingerprints found at the crime scene, then surely the defendant committed the crime, absent an innocent explanation for the person's presence at the scene.

Support for the premises in this syllogism is weaker than many jurors suppose. Proof of the uniqueness of each individuals' fingerprints is surprisingly thin and difficult to obtain (Cole, 2009; Page, Taylor & Blenkin, 2011), and the error rate associated with fingerprint examiners' conclusions is much higher than the public assumes (Garrett & Mitchell, 2018). Identification errors can and do arise more often than assumed because the standard procedure for fingerprint examination—the "ACE-V methodology" as it is commonly called within the field (Peterson et al., 2009), which stands for Analysis, Comparison, Evaluation and Verification—requires subjective judgments about whether a latent print provides sufficient detail for comparison purposes and whether the latent print is sufficiently similar to the known print to declare that the

two came from the same source. This subjectivity introduces a greater risk of contamination by adversarial allegiances and confirmation bias when the fingerprint examiner knows that a test print comes from a suspect (Dror, 2016; Murrie & Boccaccini, 2015). The lack of objective controls on the comparison process means that different examiners may reach conflicting opinions regarding the same set of prints and individual examiners may reach conflicting opinions about the same set of prints presented to them at different times (Dror & Rosenthal, 2008; Haber & Haber, 2014; Ulery, Hicklin, Buscaglia & Roberts, 2012).

Legal scholars and the criminal defense bar have long argued that judges should more closely regulate fingerprint evidence (Cole, 2001, 2018). In 2009, the National Research Council ("NRC") of the National Academies grouped fingerprint evidence with other forms of forensic pattern comparison evidence, such as ballistics and bitemark analysis, that depend heavily on subjective methods that have not been shown to produce accurate and reliable results (NRC, 2009). However, no federal appellate court or state supreme court has concluded that the ACE-V methodology is so unreliable that fingerprint evidence should not be admitted in court (Garrett & Mitchell, 2018). Only a handful of courts have deemed the use of fingerprint evidence improper on grounds that the method or data used by a particular fingerprint examiner was flawed (e.g., *Commonwealth v. Patterson*, 2005; *State v. Rose*, 2007; *State v. McPhaul*, 2017; *State v. Koiyan*, 2020; see generally Cooper, 2013). Furthermore, although critical of the limited research on the validity and reliability of fingerprint examinations and of how fingerprint examiners sometimes present their conclusions, the Presidential Council of Advisors on Science and Technology ("PCAST") did conclude that fingerprint evidence has "foundational validity" based on two studies examining error rates (PCAST, 2016, p.6).

In light of the broad acceptance of fingerprint evidence by the courts, finding effective ways to educate jurors on the risks of mistaken fingerprint identifications is vital to the interests of criminal defendants, especially where fingerprint evidence is a crucial part of the government's case against them. Defendants most commonly rely on cross-examination of the prosecution's fingerprint expert to bring out the risk of misidentification (Lawson, 2003; Garrett, 2011), but cross-examination has generally been found to have little impact on juror receptions of forensic evidence (e.g., Chorn & Kovera, 2019; Koehler, 2011; Lieberman et al., 2008; but see Thompson & Scurich, 2019). However, Garrett and Mitchell (2013) found that bringing out the risk of error during cross-examination of the prosecution's fingerprint expert did significantly reduce the weight given to the fingerprint identification by mock jurors—but only if the expert did not subsequently discount that risk of error during the cross-examination as experienced experts who understand the gist of the questioning will do.

Judges will occasionally grant a defendant's request to instruct the jury on the subjective nature of fingerprint comparisons (Sapir, 2007), but again empirical evidence casts doubt on the potency of such instructions. For instance, McQuiston-Surrett and Saks (2009) found that informing participants of the limitations of microscopic hair comparison through a judicial instruction had no effect on participants' estimates that the defendant was the source of hair found at the crime scene. Eastwood and Caldwell (2015) likewise found no effect from a judicial instruction on microscopic hair examination, despite a strongly-worded instruction critical of the specific testimony offered by the prosecution expert in the case at hand. Crozier, Grady and Garrett (2020) did find, however, that a jury instruction that specifically discussed false positive error rates from fingerprint validation studies, as opposed to an instruction that

merely explained that no expert analysis is free of error, significantly reduced the number of guilty votes in a case where fingerprint evidence was central to the prosecution.

An alternative approach involves asking the court to restrict how fingerprint examiners describe their method and conclusions to avoid juror misconceptions about the accuracy and precision of the fingerprint examination process. For instance, the U.S. Department of Justice has advised examiners not to testify that the ACE-V methodology has a zero error rate and to offer their conclusions in qualitative terms rather than impressive but unjustified quantitative terms (U.S. Department of Justice, 2020; see also International Association for Identification, 2010). Empirical research into the effects of these linguistic reforms has found that they have little effect on how jurors perceive fingerprint evidence. The key finding from several empirical studies testing different ways of describing the fingerprint examiner's method and communicating the examiner's conclusion is that jury-eligible adults attend primarily to whether or not a fingerprint identification is made; adding testimony about the small risk of error or supposed infalliblity of the comparison procedure adds little or no weight to the identification evidence because the general public already believes fingerprint evidence to be highly reliable (e.g., Garrett & Mitchell, 2013; Garrett, Mitchell & Scurich, 2018; Kadane & Koehler, 2018).

One approach that appears to be very effective is presenting jurors with examiner-specific proficiency testing information. Mitchell and Garrett (2019) found that jury-eligible adults showed considerable sensitivity to a fingerprint examiner's level of demonstrated proficiency when deciding how much weight to give to a fingerprint-based identification: on average, mock jurors who heard testimony from a fingerprint examiner who scored poorly on a recent proficiency test rated the likelihood that the defendant committed a crime to be 40% less than jurors who heard testimony from an examiner with a perfect proficiency test score.

Unfortunately, robust proficiency testing of fingerprint examiners is not yet commonly conducted or available for use at trial (Garrett & Mitchell, 2018).

II. The Present Study

This prior research reveals what might be called the public's infallibility illusion about fingerprint evidence: jurors assume that fingerprint-based identifications provide unproblematic, highly probative evidence of guilt unless a fingerprint examiner admits a possible error in the case (Garrett & Mitchell, 2013), unless jurors are instructed on documented error rates (Crozier et al., 2020), or unless jurors are shown evidence of the examiner's past mistakes using proficiency test results (Mitchell & Garrett, 2019). The problem for criminal defendants is how to establish this risk of error in a compelling way. Many courts will be reluctant to give a jury instruction detailing error rates of the kind tested in the Crozier et al. (2020) study, leaving it to defendants to establish fingerprint-comparison error rates through other means. Using cross-examination to do so, however, depends on the candor of the expert and the cross-examiner's skill.

A largely unexplored method for bringing out possible errors in the government's fingerprint evidence is the use of a rebuttal expert. This counter-measure is theoretically available to all criminal defendants, but in fact most defendants lack the resources needed to retain a fingerprint expert and must receive court-approved government funds in order to do so. Courts do not automatically grant such funding requests and often must be convinced that cross-examination of the prosecution's expert will not be an adequate means of educating the jury on possible problems with the prosecution's fingerprint evidence (e.g., *Gary v. Schofield*, 2004; *State v. Sanders*, 2019). In the absence of empirical research examining how jurors react to a

battle of the experts in the fingerprint context, it can be difficult for defendants to prove a need for a rebuttal expert. This study sought to close the gap on this important question of how jurors react to a defense expert who rebuts the testimony of the prosecution's fingerprint expert.

II.A. Battle of the Experts

If courts were to look only at existing studies of the "battle of the experts" phenomenon, reluctance to allocate funds for defense-side fingerprint experts might appear justified. Devine (2012), in his review of the impact of expert evidence on jury decision-making, concluded that "the impact of testimony by an initial expert is not dampened by a subsequent dissenting expert (p. 131)." However, Devine's conclusion was based on relatively few studies that involved experts on psychological issues, and Devine (2012) added the caveat that opposing testimony may have stronger effects in some domains.

Only a handful of studies have examined battles of forensic experts, but these studies provide reason to believe that a rebuttal fingerprint expert can be an effective foil. Eastwood and Caldwell (2015) conducted a mock sexual assault trial in which the prosecution called an expert to testify to a microscopic hair comparison that incriminated the defendant. Mock jurors exposed only to the prosecution's expert were much more likely to convict than those who heard rebuttal testimony from a defense expert about flaws in the prosecution expert's method that caused errors in that expert's conclusion. Scobie, Semmler and Proeve (2019) likewise found that opposing expert testimony increased skepticism about a prosecution expert's identification opinion based on anthropometric facial comparison (i.e., measurement and comparison of facial features, often using images captured from a surveillance video): rebuttal testimony from a defense expert reduced, but did not eliminate, the effect of the prosecution's expert by convincing jurors that the method used by the prosecution's expert was unreliable. And, although

no published research has examined a battle of fingerprint experts, Butler's (2013) dissertation research found that mock jurors exposed to a defense expert who explained the susceptibility of latent fingerprint examinations to biasing factors reduced mock juror reliance on the prosecution's fingerprint evidence.

These studies demonstrate that alarms raised by a rebuttal expert can create doubt in the minds of jurors about the reliability of the prosecution's forensic evidence. These alarms can take the form of a critique of the opposing expert's methodology or can involve a substantive disagreement with the conclusions of the opposing expert. In every case, a rebuttal expert can provide testimony that lays out problems inherent in a forensic procedure, but if the rebuttal expert has access to the source materials considered by the opposing expert, then the rebuttal expert may also offer an opinion on whether those source materials do in fact link the defendant to the crime. In the fingerprint context, this substantive rebuttal may take one of two forms: (a) an opinion that the fingerprint comparison proved inconclusive because there were insufficient points of similarity or dissimilarity between the latent and known print (either because of the partial nature or low resolution of the latent print) to reach a conclusion that the defendant was or was not the source of the latent print; (b) an opinion that the comparison excluded the defendant as the source of the latent print (Garrett & Mitchell, 2018; Ulery et al., 2013).

The present study was designed to examine the relative effectiveness of both methodological and substantive rebuttals at creating doubt about a fingerprint-based identification offered by the prosecution. Using a large, national sample of jury-eligible adults who watch realistic expert witness testimony via videotape, we examined the impact of a methodological rebuttal (explaining the risk of error in the ACE-V methodology and summarizing studies showing errors in that process) and both types of substantive rebuttal (an

opinion that the comparison excluded the defendant or an opinion that the comparison was inconclusive) in a mock trial of a robbery charge where fingerprint evidence was crucial to the government's case. Compared to a baseline condition in which mock jurors only hear from the government's fingerprint expert who attributed a latent fingerprint from the crime scence to the defendant, we predicted that all three types of rebuttal evidence would cause jurors to question their belief in the reliability of fingerprint identifications and adjust downward their estimates of the likelihood that the defendant was the robber. We expected this effect to be greatest when the abstract risk of error discussed in the methodological rebuttal was made concrete by the substantive rebuttals that established error on the part of the government's expert. The methodological rebuttal should raise concerns about the fallibility of the prosecution expert, while the substantive rebuttals provide reason to believe that the prosecution's examiner is not only fallible but has in fact erred in the case at hand.

In addition, we hypothesized that individuals would differ in their openness to the rebuttal evidence as a function of their concerns about the adverse effects of a false conviction versus a false acquittal. Mitchell and Garrett (2019) found, in a large national survey, that most respondents believed that false convictions and false acquittals were equally harmful to society, but substantial minorities believed that either false convictions or false acquittals caused greater societal harm and were thus more worrisome. They also gathered evidence suggesting these error aversions will affect how evidence in a criminal case is perceived. Based on this prior research, we hypothesized that those with stronger aversions to false convictions would be more influenced by the rebuttal evidence because they are motivated to be skeptical of government prosecutions, while those who have a greater aversion to false acquittals would be less influenced by the rebuttal because they are motivated to accept the government's evidence. A

battle of the forensic experts is a particularly good context to examine the evidentiary implications of these error aversions because laypersons have no objective basis for evaluating the accuracy of either witness and must choose which side should bear the risk of a mistake about the forensic evidence. We predicted that differentiation between those with opposing error aversions should be greatest in the methodological rebuttal condition, where those inclined to believe the government will likely dismiss the abstract risk of error, while those who worry about false convictions are likely to resolve uncertainties in favor of the criminal defendant.

II.B. Inoculation Against Rebuttal Evidence

A party that expects its expert to be challenged by a rebuttal expert is not defenseless, but rather can elicit testimony from its expert aimed at inoculating her opinions from the coming attack. Just as exposing the body to a weakened virus in the form of a vaccine prepares the immune system to repel the attack of a full-strength virus, exposing an audience to a weakened form of a future persuasive appeal prepares the audience to rebuff that appeal and maintain allegiance to its original belief (McGuire and Papageorgis, 1961, 1962).

The most notable research on inoculation in the context of trial was undertaken by Williams and colleagues, who conducted a series of studies examining the conditions under which pre-emptively disclosing evidence harmful to one's case reduces the impact of that evidence. Williams, Bourgeois and Croyle (1993) contrasted outcomes in trials in which a party brought out damaging evidence on its own, the opposing party brought out the evidence, or a party brought out the damaging evidence but then the opponent discussed that evidence. In one of their experiments, the potentially damaging information concerned an expert who took a position in an earlier case that could be perceived as in conflict with the position taken in the pending case. Pre-emptively disclosing this impeachment evidence reduced its negative impact.

In follow-up studies, Dolnik, Case and Williams (2003) and Howard, Brewer and Williams (2006) replicated the inoculation effect, but also delineated limiting conditions. First, they found that to inoculate successfully it was not necessary to frame the damaging evidence in a way that downplayed its importance, but they also found the opponent could overcome the inoculation by revealing to the jury that the first party sought to diminish the impact of the evidence by pre-emptively disclosing it (Dolnik et al., 2003). Second, they found inoculation succeeded only when jurors were not attending closely to the evidence (Howard et al., 2006), suggesting inoculation works best in complex trials or for evidence not central to the case.

In another experiment involving an expert witness, Ziemke and Brodsky (2015) examined whether having a defense expert acknowledge during direct examination that he was being paid and that he often testified for criminal defendants would deflect a prosecution effort to portray the expert as a "hired gun." Ziemke and Brodsky found no beneficial effect from the inoculation and in fact found that the expert who waited to address these facts on cross-examination was viewed as marginally more credible. In contrast, Garrett and Mitchell (2013) found that a fingerprint expert who admitted during direct examination that fingerprint comparisons do pose a small risk of error, but then immediately discounted that risk in the case at hand, successfully avoided the adverse effects associated with merely admitting errors have been found in fingerprint comparisons.

Drawing on Garrett and Mitchell (2013), as well as testimony from transcripts in real trials, we developed inoculation testimony for the prosecution's expert that acknowledged that fingerprint comparisons are not error free but then emphasized the small number of known errors from real cases, asserted that academic studies of fingerprint examiners only find "very low" rates of error, and ended with a statement of confidence that the identification in the case at hand

was correct. Given the prior success of similar language at preserving the probative value of a fingerprint identification, we expected this inoculation to prevent the defense's methodological rebuttal from reducing the weight of the prosecution's fingerprint evidence. However, we did not expect this inoculation to succeed in blunting the force of a substantive rebuttal because the inoculation did not explain why the rebuttal expert's identification opinion was wrong (i.e., it did not inoculate against the main threat posed by the substantive rebuttals). Moreover, where the defense expert offers a substantive rebuttal, resolving the conflict between the experts' identification opinions will be central to the jurors' task in the case, a condition that makes inoculation less likely to succeed (Howard et al., 2006).

III. Method

III.A. Sample

We commissioned Qualtrics to recruit participants from the U.S. using quotas designed to create a sample representative of the U.S. population with respect to race/ethnicity, sex, age, income, and geographic location. A total of 1,716 adults passed three attention checks built into the survey at different locations and received approximately $4 each for their participation, which on average took less than 20 minutes (average time to completion was 18.93 minutes). Nine hundred eleven participants self-identified as female (53.1%) and 803 as male (46.8%). Median participant age was 53, with a range of 18 to 91, which places our sample's median age above the U.S. median age of 38 as reported by the Census Bureau (Rogers, 2019), however, older persons are often disproportionately represented on juries (e.g., Anwar, Bayer & Hjalmarsson, 2014; Shelton, 2010). One thousand eighty-one participants self-identified as White (63%), 228 as Black or African-Americans (13.3%), 281 as Hispanic (16.4%), 92 as Asian (5.4%), six as American Indian or Alaska Native (.3%), three as Pacific Islander or Native

Hawaiian (.2%), and 23 as other (1.3%). Participants resided in the West (23.7%), Midwest (21.9%), South (36.2%) and Northeast (18.2%) regions of the U.S. Five and one-half percent of participants reported annual family incomes less than $10,000; 32.5% reported annual family incomes between $10,000 and $39,999; 42.7% reported incomes between $40,000 and $99,999; 18% reported incomes of $100,000 or greater. Approximately 39% of the sample held a two- or four-year college degree, 15% held a post-graduate or professional degree, 24% reported having attended college without receiving a degree, 20% graduated high school and did not attend college, and 2% did not graduate high school. More participants reported consistently voting for Democratic (42.4%) than Republican (29.9%) candidates, with the remainder stating that they have no consistent preference between the two main political parties (27.6%).

III.B. Procedure

Participants anonymously completed the web-based experiment on their own computers or smart phones. After providing informed consent (as approved by the institutional review board of the corresponding author's institution), participants answered background questions and then were randomly assigned to one of 17 conditions: the factorial combination of our three independent variables—expert actor identity (2 levels), prosecution expert evidence (2 levels: identification of defendant as source of latent print or identification of defendant as source of latent print with inoculation language added), and defense expert rebuttal (4 levels: none, methodological rebuttal, substantive rebuttal based on inconclusiveness of the print comparison, or substantive rebuttal asserting the print comparison excluded the defendant as the latent print source)—produced 16 experimental conditions; the seventheeth condition was the control condition, in which participants were not exposed to any fingerprint evidence from the prosecution or defense. After answering questions about the mock case, participants answered

final questions asking for their views about the general reliability of fingerpreint and DNA evidence.

To ensure adequate power to detect even small effects, all experimental conditions had a minimum of 100 participants; the control condition had 82 participants. A comparison of two means using a sample size of 182 has an 80% probability of detecting a small effect size (e.g., $\eta^2 = .01$) and a 98% probability of detecting a medium effect size (e.g., $\eta^2 = .09$) (Aberson, 2010; Murphy & Moors, 2004). Most of our comparisons involved samples larger than $n = 182$.

III.C. Materials

The expert witness videos and questionnaire used in this study, as well as the data collected, can be accessed at https://osf.io/hxr3g/. The questionnaire first asked participants to provide background information concerning demographics (age, sex, race/ethnicity, family income, education, and area of residence) and political views (placement on liberal-conservative continuum and political party support). Participants were also asked to indicate whether they believed that false acquittals or false convictions caused more harm to society or were equally harmful.

After these background questions, participants received a description of a criminal case in which the defendant had been charged with robbery and was now standing trial. Participants assigned to the control condition received the following case information:

> A convenience store was robbed. The robber wore a mask and showed a gun but did not fire the gun. When running from the store, the robber's hand caught on the door, causing him to drop the gun. No other person handled the gun before it was secured by the police. The police arrested a person who was found in the vicinity shortly after the robbery. No

proceeds of the crime were found on this person, and the clerk at the convenience store has not been able to identify this person as the robber because the robber wore a mask.

Participants assigned to one of the conditions involving fingerprint evidence were additionally told that a fingerprint was recovered from the gun dropped by the assailant and were then shown videotaped testimony of the prosecution's fingerprint examiner. If the participant was assigned to one of the battle-of-the-expert conditions, the participants was then shown videotaped testimony of the defense's fingerprint examiner. (The appendix contains the full scripts of the testimony used by the prosecution and defense experts in the different trial conditions.)

All videos were closed captioned, and participants were not allowed to proceed to the next webpage until sufficient time had passed for each video to have been fully viewed. Because the battle-of-expert conditions required videotaped testimony from both a prosecution and defense expert, we trained two experienced actors to play both roles using scripted language for each role, and we ran every battle-of-experts condition with each expert serving as either the prosecution or defense expert. Two white, male experts were used to control for possible race and gender effects.

Participants assigned to one of the fingerprint evidence conditions first watched videotaped testimony from the prosecution's fingerprint examiner. In this video, the prosecution's expert first answers questions about his qualifications and the method he used to compare the defendant's fingerprints to a latent fingerprint recovered from the handgun dropped at the scene of the crime. The prosecution expert then explains that the defendant was determined to be the source of the print found on the handgun. If a participant was assigned to

the condition in which the prosecution attempts to inoculate against concerns that may arise about the accuracy of their expert's attributing the print to the defendant, then the participants saw additional testimony in which the procesution's expert acknowledges that some studies have found errors in fingerprint examinations but asserts that the observed error rates were very low and that he is confident in his conclusion in this particular case.

If the participant was assigned to one of the battle-of-experts conditions, then, after watching the video of the prosecution expert, the participant was shown one of three defense expert videos. In all of these videos, the defense expert first answers questions setting out the expert's qualifications and experience as a fingerprint examiner.

In the methodological rebuttal, the defense expert then discusses two studies that have established error rates for latent fingerprint identifications and emphasizes the subjectivity surrounding fingerprint examinations and the difficulty of making comparisons if the latent print is of poor quality. In the condition with only the methodological rebuttal, the defense's expert ends his testimony by explaining that he did not have an opportunity to examine the latent fingerprint involved in this case.

In the substantive rebuttal/inconclusive comparison condition, participants see the same testimony as in the methodological rebuttal until the end, when the defense expert explains that he did have an opportunity to examine the latent print in this case and found the latent print not to be suitable for comparison due to its poor quality. In the substantive rebuttal/defendant not the source condition, the defense expert testifies that he compared the latent print to the defendant's prints and concluded that the defendant was not the source of the latent fingerprint and therefore the fingerprint must have come from a different person.

After reading the case description and watching any applicable expert testimony, participants completed the primary dependent measures: (a) What is the likelihood that the defendant committed the robbery? (answered on a scale ranging from 0% to 100% likely); (b) Based on the evidence in this case, would you convict the defendant? (answered yes or no). Finally, participants were asked to rate the reliability of fingerprint evidence and DNA evidence in general (both rated on six-point scales ranging from very reliable to very unreliable).

IV. Results

IV.A. Analytic Plan

We followed an analytic plan in which we first examined whether participants responded differently to the two actors playing the role of the prosecution and defense expert witnesses. If the actors were not viewed as equivalents when testifying for the prosecution or defense, then we planned to conduct separate tests for expert testimony effects for each actor (i.e., we would control for actor identity and examine testimony effects). If the actors were viewed as equivalents, then we planned to disregard actor identity for the remaining statistical tests.

After examining possible actor effects, we planned to examine whether the prosecution's attempt to inoculate its expert from the rebuttal testimony affected reception of the prosecution expert's testimony (i.e., we plan to examine the effects of the prosecution testimony with and without the inoculation language). If the inoculation variable affected participant responses, then we planned to examine separately the effects of the rebuttal testimony in the presence and absence of the inoculation language; if the inoculation variable had no effect, this variable would be disregarded in comparisons of the effects of the prosecution expert's testimony in the presence and absence of rebuttal expert testimony.

The third step in our analytic plan involved examination of the effect of the prosecution testimony alone and in the presence of rebuttal testimony: (a) participant judgments about the defendant's guilt in the control (no expert) condition were contrasted with judgments in the prosecution expert only condition to determine whether the prosecution expert's testimony impacted mock jurors' judgments; (b) if so, then the control and prosecution expert only conditions would be compared to the conditions in which rebuttal expert testimony was offered using post hoc tests employing adjustments for the heightened risk of Type I errors due to multiple comparisons.

Finally, we planned to contrast the responses of participants with different aversions to false convictions and false acquittals within each experimental condition, to determine whether these value differences affected how the prosecution or defense expert testimony was received. An exploratory analysis using demographic information about participants was also planned to examine whether participant age, race, gender, income, or political views related to views of the case.

IV.B. Test for Equivalence of Expert Actors

We began our analyses by examining whether either actor was more convincing when playing the role of the prosecution or defense expert. Overall mean estimates of the likelihood that the defendant committed the robbery were virtually identical whether Actor 1 or Actor 2 played the role of the prosecution expert (M = 63.8 vs. 62.23), $t(1632) = .73$, $p = .47$, or the role of the defense expert (M = 57.48 vs. 58.40), $t(1223) = .63$, $p = .53$, and actor identity did not interact with the expert testimony content variables (i.e., the content of the prosecution or defense expert's testimony) (all t's < 1 and p's $> .35$ for tests of actor identity effects on all expert testimony variables). The percentage voting for conviction likewise did not depend on

which actor played the role of the prosecution expert, $\chi^2(1) = .01$, $p = .93$, or defense expert, $\chi2(1) = .03$, p = .88. These results indicate that the actors were equally persuasive when playing the role of either expert. Therefore, any observed differences in the probability of conviction across experimental conditions can be attributed to the content of the experts' testimony rather than the acting ability or personal appeal of the actor playing the respective experts.

IV.C. Test for Inoculation Effects

Turning to the effects of the content of the expert testimony, we first examined whether jurors responded differently to the prosecution expert when the expert acknowledged the risk of error but then discounted that risk as part of the expert's direct testimony. Our prediction that this language would inoculate against the effects of the methodological rebuttal turned out to be wrong: estimates of guilt when the prosecution expert added inoculation language before the methodological rebuttal ($M = 66.90$) did not differ from estimates when the prosecution expert did not inoculate against the coming methodological rebuttal ($M = 65.77$), $t(406) = .46$, $p = .65$. We then examined the remaining experimental conditions and found that adding the inoculation language never affected estimates of the likelihood that the defendant committed the crime (comparison of the inoculation and no-inoculation testimony in the trial without a defense rebuttal, $t[407] = .20$, $p = .84$; comparison versus inconclusive-comparison rebuttal, $t[407] = .05$, $p = .96$; with the exclusion rebuttal, $t[406] = 1.50$, $p = .13$). The percentage voting for conviction also did not differ significantly whether the prosecution expert added the inoculation language to his testimony or not (comparison of the inoculation and no-inoculation testimony in the trial without a defense rebuttal, $\chi^2[1] = 1.04$, $p = .31$; versus the methodological rebuttal, $\chi^2[1] = 1.62$, $p = .20$; versus the inconclusive-comparison rebuttal, $\chi^2[1] = 1.12$, $p = .29$; versus the exclusion rebuttal, $\chi^2[1] = .41$, $p = .52$). In sum, the inoculation tactic did not succeed, but using it did not

harm the prosecution's case, either. Because the inoculation language had no positive or negative effects, we did not distinguish between the two variants of the prosecution expert's testimony in subsequent analyses.

IV.D. Tests for Effects of Testimony by Prosecution Expert and Rebuttal Expert

Figure 1 displays mean estimates of the likelihood that the defendant committed the robbery and the percentage of jurors voting for conviction across the different trials. Compared to the control condition, in which no fingerprint evidence was presented, hearing testimony fron only the prosecution expert increased average ratings of the likelihood that the defendant committed the crime by more than 25 percentage points, t (489) = 9.94, $p < .0001$, $\eta_p^2 = .17$, 95% CI [23.67, 35.34], and increased the number of jurors voting for conviction by more than 50 percentage points, $\chi^2(1) = 84.01$, $p < .001$, $\varphi = .41$. Mock jurors found the prosecution expert's testimony to be strong evidence of the defendant's guilt.

Insert Figure 1 about here

However, all three defense rebuttals proved effective in creating doubt about the government's case, with the substantive rebuttals proving most effective. Table 1 presents the results of all pairwise comparisons of the control and expert testimony conditions for the likelihood of guilt dependent variable using Tukey's HSD test, which controls for increased risk of Type I errors due to multiple comparisons. Table 2 presents the results of pairwise Chi-square tests among the control and experimental conditions, with a Bonferroni correction applied to account for multiple comparisons. Estimates of the likelihood that the defendant committed the robbery were significantly lower in the presence of the defense expert's methodological rebuttal

as compared to estimates when jurors heard only from the prosecution's expert, and the number voting for conviction dropped significantly—from 76% to 58%—when jurors heard the methodological rebuttal. Adding either substantive rebuttal led to significantly lower estimates that the defendant committed the crime as compared to when only the methodological rebuttal was heard, and significantly lower numbers voting for conviction. Indeed, both of the substantive rebuttals produced conviction vote rates statistically indistinguishable from the conviction vote rate observed in the control condition, where no fingerprint evidence was presented. In sum, all of the rebuttals substantially reduced perceptions of the defendant's guilt, but the substantive rebuttals completely neutralized the effect of the prosecution's fingerprint evidence on the willingness of jurors to vote for conviction.

Insert Tables 1 and 2 about here

In order to understand the relationship between mock jurors' level of certainty that the defendant committed the crime and their willingness to vote for conviction, we grouped votes for conviction as a function of the estimated likelihood that the defendant committed the crime, using Chi-square automatic interaction detection (CHAID) decision tree analysis in SPSS. As shown in Figure 2, whenever estimates of the likelihood that the defendant committed the crime dropped below 60%—as happened on average whenever the defense expert provided substantive rebuttal testimony—participants were more likely to vote for acquittal than conviction. In addition to demonstrating the importance of the rebuttal testimony, the decision tree illustrates the willingness of a number of jurors to vote for conviction with surprisingly low levels of certainty, with some willing to convict on estimates below 50%.

Insert Figure 2 about here

To test our prediction that exposure to the rebuttal testimony would shake jurors' belief in the infallibility of fingerprint evidence, we examined participants' judgments about the general reliability of fingerprint evidence and DNA evidence, judgments that were made after participants had been exposed to the mock trial evidence. Participants in the control condition, who were not exposed to any expert testimony on fingerprint evidence, rated both fingerprint evidence and DNA evidence near the top of the general reliability scale (M = 5.09 and 5.48, respectively, which placed both between Reliable and Very Reliable on the scale). Compared to those in the control condition, participants who heard from only the prosecution's fingerprint expert rated the general reliability of fingerprint evidence to be significantly higher (M = 5.35), $t(489) = 2.75$, $p = .006$, $\eta_p^2 = .02$, 95% CI [.08, .45]. Those exposed to a methodological rebuttal rated the general reliability of fingerprint evidence significantly lower (M = 4.88) than those who heard only from the prosecution expert, $t(815) = 7.75$, $p < .001$, $\eta_p^2 = .07$, 95% CI [.35, .59]. However, the methodological rebuttal did not produce ratings lower than those observed in the control condition, $t(488) = 1.83$, $p = .07$. Viewing the substantive rebuttals did adversely affect perceptions of fingerprint evidence relative to the baseline set by the control condition: inconclusive rebuttal (M = 4.68) compared to control (M = 5.09 , $t(489) = 3.55$, $p < .001$, $\eta_p^2 = .03$, 95% CI [.18, .62]; exclusion rebuttal (M = 4.67) compared to control, $t(488) = 3.77$, $p < .001$, $\eta_p^2 = .03$, 95% CI [.20, .64]. Hearing testimony about fingerprint evidence from a fingerprint expert for the prosecution or defense had no effect on ratings of the general reliability of DNA evidence (all t's < 1).

IV.E. Test for Error Aversion Effects and Demographic Effects

Our final analyses examined possible individual differences in receptivity to the expert evidence on fingerprints. First, we tested our prediction that persons with stronger aversions to false acquittals than false convictions would be less receptive to the defendant's rebuttal testimony. In our sample, the majority of participants (1117 or 65%) stated that they view false convictions and false acquittals to be equally harmful to society, but substantial minorities believed either that false convictions are worse (373 or 22%) or that are false acquittals are worse (226 or 13%). As shown in Figure 3, the latter two groups responded differently to rebuttal testimony that raised methodological concerns, $t(143) = 2.97$, $p = .003$, $\eta_p^2 = .06$, 95% CI [4.43, 22.02], and to rebuttal testimony that the fingerprint comparison was inconclusive, $t(141) = 3.38$, $p = .001$, $\eta_p^2 = .08$, 95% CI [5.87, 22.39]. In addition to these differences in estimates of guilt, those averse to false acquittals convicted at significantly higher rates than those averse to false convictions in the methodological rebuttal condition, $\chi^2(1) = 11.07$, $p = .001$, $\varphi = .28$, and in the inconclusive-comparsion rebuttal condition, $\chi^2(1) = 6.92$, $p = .009$, $\varphi = .22$.

We successfully predicted that these two groups would resolve doubts about fingerprint evidence differently in the methodological rebuttal condition, but we failed to predict a similar effect where the defense expert opined that the print comparison was inconclusive. Those with strong aversions to false acquittals apparently reconciled the inconclusive rebuttal with the prosecution's identification opinion, because they maintained high estimates of guilt, while other jurors appear to have seen the opinons as irreconcilable and accordingly had greater doubt about guilt. However, once the prosecution and defense expert conclusions were directly opposed—as happened in the exclusion rebuttal condition—those averse to false acquittals no longer exhibited

significantly higher estimates of guilt than those averse to false convictions, $t(146) = 1.06$, $p = .32$, nor did they vote for conviction at a significantly higher rate, $\chi^2(1) = 3.25$, $p = .07$.

Insert Figure 3 about here

Finally, we examined whether demographic groups differed in their reactions to the expert testimony using a regression analysis in which participant age, income, education, gender, race, and political views, as well as expert testimony content, served as predictors of estimates of the likelihood that the defendant committed the robbery.[1] Collectively, these variables explained 16% of the variance in responses ($R = .40$), with age ($\beta = .09$, $p < .01$), race ($\beta = -0.08$, $p < .01$), and income ($\beta = 0.12$, $p < .01$), significantly improving model estimates of the likelihood that the defendant committed the crime compared to a model using only expert testimony content as the predictor. Increasing age and income were associated with increased estimates of the likelihood that the defendant committed the crime, while Hispanic and African-American participants tended to give lower estimates of the likelihood that the defendant committed the crime. Although none of these individual difference variables exerted tremendous influence on judgmetns about the case, these results suggest that, all things being equal, younger, lower-income minorities will likely be more skeptical of the prosecution's case, and more open to rebuttal evidence, than other potential jurors.

V. Discussion

Fingerprint evidence is more often collected and analyzed in serious cases, such as homicides and rapes (Baskin & Sommers, 2012; McEwen & Regoeczi, 2015; Sommers &

[1] We excluded participants in the control condition from these analyses because they were not exposed to any expert evidence.

Baskin, 2011). Therefore, when the government plans to use fingerprint evidence to help prove its case, the stakes of the case are likely to be high. The present study demonstrated that criminal defendants may benefit greatly from waging a battle of experts at trial. We found the greatest benefit from an expert rebuttal that paired information about errors in the fingerprint-comparison process with testimony that the prosecution's expert had made an error in this case, particularly testimony that the fingerprint comparison excluded the defendant or that the print comparison proved inconclusive. But a methodological rebuttal alone, which discussed the subjective nature of fingerprint comparisons and summarized academic studies on error rates in fingerprint identification, caused many mock jurors to view the prosecution's case as substantially weaker and significantly reduced the number of persons voting for conviction.

The study advances our understanding of how jurors perceive fingerprint evidence and how to alter those perceptions. Consistent with prior research (e.g., Mitchell & Garrett, 2019), we found that jurors come to trial believing that fingerprint evidence is generally reliable evidence, and hearing testimony only from an expert for the prosecution fortifies that belief. Accordingly, when given no reason to question the accuracy of a fingerprint-based identification, our jurors found the government's fingerprint evidence to be compelling evidence of guilt and left the trial with an even stronger belief in the general reliability of fingerprint evidence. Yet when jurors learned details about fingerprint comparison methods and about academic studies finding errors in this process from a credible expert source, significant numbers of jurors were no longer willing to convict and adjusted their confidence in fingerprint evidence downward. And when jurors were given specific reasons to believe that the prosecution's expert had erred from hearing the substantive rebuttal testimony, conviction rates dropped near or to the same level observed in the absence of any fingerprint evidence. Jurors left these trials with worse views

about the general reliability of fingerprint evidence. Educating jurors on general problems with fingerprint identifications increases caution about the government's case, but demonstrating the fallibility of the process by presenting conflicting conclusions from two experts who supposedly used the same procedure makes the risk of error inescapable: one of these experts must be wrong.

Past research has found quite limited effects from cross-examining fingerprint experts about possible errors and educating jurors on the general risks of the ACE-V methodology (e.g., Garrett & Mitchell, 2013; Crozier et al., 2020). A much more powerful way to create doubt is to inform jurors that the testifying fingerprint examiner exhibited poor performance on a recent proficiency test (Mitchell & Garrett, 2019). Our results demonstrated that a rebuttal expert can also have very powerful effects, especially where the rebuttal expert discusses likely errors in the identification at issue in the case.

This research also demonstrated that the effects of the rebuttal will depend not only on the content of the rebuttal testimony, but also the values that jurors bring to trial. We found that jurors who believe that false acquittals cause more harm to society than false convictions showed little concern about the government's fingerprint evidence after hearing testimony about method limtations, and even after testimony that the latent fingerprint should not have been used in the fingerprint comparison. However, once the rebuttal expert testified that the fingerprint comparison excluded the defendant, those averse to false acquittals revised their perceptions of guilt in line with the behavior of those who worry less about false acquittals.

These results suggest an important role for trial error aversions in motivated reasoning about ambiguities in evidence presented at trial, but only for those who see one trial error as clearly worse than the other. A common measurement approach assumes that jurors deem one

trial error worse than the other (e.g., Givatti, 2019), but the great majority of our participants were equally concerned about false convictions and false acquittals. Studies that force respondents to choose between the two errors may inadvertently obscure persons for whom these values are much more important and more behaviorally potent. If further research shows that error aversions have robust consequences for juror expectancies (cf. Lecci & Myers, 2002; Myers & Lecci, 1998) and juror behavior, then these value differences could be an important consideration in jury selection given that it should be possible to uncover these aversions during voire dire, without the aid of a pretrial jury questionnaire.

The results also suggest that greater attention should be given to battles of experts and the conditions under which such battles matter to the outcome of a case. Most of the prior research on expert battles involved psychological experts whose testimony often addressed disputes over the defendant's mental state or eyewitness reliability with minimal impact whether there was a rebuttal expert or not (see Devine, 2012; Nietzel, McCarthy & Kern, 1999). Debates among forensic experts often involve core factual issues in a case and involve techniques about which jurors often have misconceptions (e.g., Martire et al., 2019), conditions that should allow rebuttal experts to have a greater influence. These conditions also make inoculation against a rebuttal less likely to succeeed. Consistent with the findings of Dolnik et al. (2003), our results demonstrate the limited role inoculation is likely to play when experts battle over key evidence in a case. This line of research suggests that it will be difficult to inoculate against salient, important evidence that may be damaging to one's case.

However, we observed no backfire effect from the prosecution's inoculation effort, suggesting that prosecution attorneys may suffer no harm from seeking to develop a more effective inoculation statement. Our inoculation testimony acknowledged the risk of error but

explained why that risk was not present here; one alternative approach would be to seek to undercut the credibility of the anticipated rebuttal expert, perhaps by characterizing that expert as a "hired gun" or with evidence of that expert's own prior mistakes. Given the potential impact of rebuttal testimony on juror perceptions of forensic evidence, the parties have a strong interest in developing effective counter-measures.

Ambiguities in application of the ACE-V methodology open the door for disagreements among fingerprint examiners about the proper conclusion to reach from the same sets of fingerprints (e.g., Dror & Rosenthal, 2008). When disagreement exists, a rebuttal expert can give substantive testimony about the probative value of the latent fingerprints in case, and our results suggest that testimony will be more impactful than a methodological rebuttal. Nevertheless, it it is important to emphasize that even the methodological rebuttal alone created significant doubt in the minds of many of our mock jurors. In light of the recent U.S. Supreme Court decision declaring that the Sixth Amendment requires unanimous jury verdicts in all trials of serious offenses (*Ramos v. Louisiana*, 2020), any rebuttal that creates reasonable doubt in the mind of just one juror may be sufficient to avoid conviction.

The chance to create this doubt should not depend on the financial resources of the defendant. In *Ake v. Oklahoma* (1985), the Supreme Court held that the Due Process Clause of the Fourteenth Amendment requires the government to provide funds to retain a psychiatric expert if that expert necessary to a defense. Most courts have extended the holding of *Ake* to cover any expert who may be crucial to a defense (Giannelli, 2003). Our study shows that using a rebuttal expert will provide jurors with information that may not be easily elicited through cross-examination and that may greatly alter jurors' views of the government's case. Our results

thus support the view that a rebuttal fingerprint expert should be deemed necessary to the defense whenever fingerprint evidence is an important part of the government's proof.

Our findings likewise have implications for convicted defendants who seek a new trial on grounds that their Sixth Amendment right to counsel has been violated. To obtain a new trial on grounds of ineffective assistance, a defendant must show that her counsel failed to take reasonable steps to challenge important evidence in the government's case, such as inculpatory fingerprint evidence, and that the defendant suffered prejudice as a result (*Strickland v. Washington*, 1984). First, in light of the demonstrated effectiveness of the various rebuttals from our study, a defense lawyer who relies on cross-examination rather than a rebuttal expert—especially a lawyer who lacks experience dealing with forensic evidence—to impeach the government's fingerprint evidence has arguably acted unreasonably. Second, our results support the inference that calling a rebuttal expert would have altered the jury's view of the fingerprint evidence. Whether a defendant suffered prejudice from a lack of a rebuttal expert will depend on other evidence in the case, but our results supports an inference of prejudice whenever a fingerprint identification serves as the government's main inculpatory evidence.

VI. Limitations and Directions for Future Research

Although we employed highly realistic expert evidence and utilized a national sample of adults to serve as mock jurors, we did not utilize deliberating juries and did not allow cross-examination of the two fingerprint experts. The results from deliberating jurors often correlate highly with those of non-deliberating jurors, but deliberation does occasionally alter the results on outcome variables (Bornstein & McCabe, 2005), and cross-examination can increase skepticism about expert testimony (e.g., Garrett & Mitchell, 2013). We simply cannot say

whether jury deliberation or cross-examination of the experts would have altered any of our results, and these possibilities deserve attention to determine the robustness of our results.

Also, as is common within mock juror studies involving forensic evidence (e.g., McQuiston-Surrett & Saks, 2009; Schklar & Diamond, 1999; Scurich & John, 2013; Thompson, Kaasa & Peterson, 2013), we employed a simple case where fingerprint evidence was crucial to the prosecution's case. We purposefully provided little other incriminating evidence to avoid bolstering the prosecution's fingerprint evidence through corroboration; corroborating evidence can lend credibility to the fingerprint identification and allay concerns jurors might otherwise have about the reliability of the fingerprint identification process. Where credible evidence corrobates the fingerprint identification, a critique from a rebuttal expert may be less persuasive. Future research should examine the impact of rebuttal testimony in the presence of evidence that corroborates the government's case. It is possible that doubts raised about the government's fingerprint evidence will spread to other evidence in the case, but this possibility awaits testing.

A related concern, given the focus of our trial on fingerprint evidence, is that jurors responded to cues in the experiment about when to give more and less weight to the prosecution's fingerprint identification. The design of the experiment and pattern of results cast doubt on the view that merely a demand effect was at work. First, we used a between-subjects design, which made it less likely that participants would infer the researchers' hypothesized effects because participants were not aware of changes in the variables across the experimental conditions. Second, the ordering of effects we observed—with jurors differentiating among all three types of rebuttals in their perceptions of guilt—paired with the different effects of the rebuttals on perceptions of the general reliability of fingerprint evidence, indicates that jurors responded to the content of the testimony, and not simply experimenter demands. Third,

differences in responses to the rebuttal evidence among the error aversion groups suggest that many jurors either did not perceive demand effects, or did not feel obliged to respond to those demands. Finally, even if some jurors merely exhibited a demand effect, we would argue that such responsiveness to the evidence would not undercut the significance of the results, because we were testing to see if jurors would respond to relevant information that should impact their decisions.

An important avenue for future research is exploring whether our results generalize to other types of forensic evidence. A common thread running through studies of the impact of forensic evidence on juror decision-making is that jurors give great weight to whether the forensic evidence incriminates the defendant or not and to the likelihood that someone else may be the source of that evidence, while variations in how this information is presented to jurors and even statistical information that should affect the weight of the evidence have little impact (Devine, 2012). We framed our rebuttals with this theme in mind to focus jurors on the likelihood that the incriminating evidence could have been supplied by someone else, and this approach may well bear fruit in any forensic science domain where jurors are prepared to defer to the experts' judgment about whether the evidence incriminates the defendant or not. The few existing studies of forensic expert battles suggest that this approach will generalize. Scobie et al. (2019) found a positive but limited effect of a methodological rebuttal in a case involving anthropometric face comparison, and Eastwood and Caldwell (2015) found a stronger effect from a substantive rebuttal in a case involving microscopic hair comparison. Jurors believe that many forms of forensic evidence are accurate and reliable, and as a result tend to find forensic evidence to be quite persuasive (Lieberman et al., 2008; Martire et al., 2019). Given the uncertainties surrounding the identification procedures that underlie several common forms of

forensic evidence (NRC, 2009), finding effective ways to educate jurors about the risk of identification errors should be a priority for jury researchers.

VII. Conclusion

Many defense counsel rely solely on cross-examination to attack the prosecution's fingerprint evidence. Our results cast doubt on the wisdom of that approach. Providing jurors with an alternative perspective on fingerprint evidence through a rebuttal expert, especially one who identifies specific errors made by the prosecution's expert, can have a tremendous impact on juror acceptance of a fingerprint identification. Where a fingerprint identification is key to the case, defendants should retain their own fingerprint experts to scrutinize the government's fingerprint evidence, and courts should provide funding for such expert assistance if necessary.

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Appendix: Scripts for Expert Witness Testimony

The expert witness videos used in the study may be viewed at https://osf.io/hxr3g/.

Experienced actors played the role of the experts and testifying using the following scripts:

Prosecution Fingerprint Expert Testimony: Source Attribution

Q. Good afternoon.
A. Good afternoon.
Q. Can you please introduce yourself to the jury?
A. Yes. My name is Patrick West.
Q. How are you employed?
A. With the state crime lab.
Q. And do you have a particular duty or title?
A. I am a latent fingerprint specialist.
Q. How long have you been employed with the state crime lab?
A. For 12 years.
Q. How long as your title been latent fingerprint specialist?
A. For all of those 12 years.
Q. And prior to your employment at the state crime lab, were you employed elsewhere?
A. Yes.
Q. Where?
A. The Federal Bureau of Investigation.
Q. And what was your job there?
A. I was a fingerprint examiner.
Q. What was the description of that job?
A. I had one year of training in everything that had to do with fingerprinting. For my second year, I filed, searched, and retrieved fingerprint information, as well as inked prints.
Q. What are inked prints?
A. Those are ten-print cards, where a person's complete set of fingerprints are inked.
Q. What kinds of training did you receive at the FBI?
A. There was classroom training with fingerprint specialists and we conducted fingerprint examinations under the supervision of experienced specialists.
Q. Since then have you had additional training?
A. Yes. I regularly attend conferences, training seminars, and instructional classes.
Q. Are you currently a member of any professional organizations?
A. Yes. I am currently a member of the International Association for Identification. It is a dues paying organization and it is basically the leading organization in my field.
Q. Over the course of your 12 years at the state crime lab, approximately how many latent fingerprint examinations and comparisons have you conducted?
A. Probably 500,000 comparisons.
Q. Can you explain, by the way, what latent prints are?

A. Fingerprints are formed before birth, and they remain the same until after death, barring deep scarring. The underside of our fingers and hands and feet are covered with raised skin, called friction skin, which is usually covered with a thin film of perspiration or oil. When the finger or hand touches an item, a reproduction of those ridges is left by means of that perspiration or oil. That reproduction is called a latent print.
Q. And when you compare latent prints to prints from a known person, is there a particular way that you do that?
A. Yes.
Q. Describe that method.
A. It's called the ACE-V method. That stands for Analysis, Comparison, Evaluation, and Verification. In this process, the examiner first determines whether the print is suitable for comparison, based on whether there is adequate information in it. If so, then the examiner makes a side-by-side comparison between the latent print and a known print taken from a suspect. Next, the examiner evaluates the degree of similarity between the latent print and the known print and can conclude that the prints are the same, different, or that the comparison is inconclusive. Finally, if the examiner decides that the prints could have come from the same person, the prints are passed to another examiner, to verify that conclusion.
Q. Did you examine a latent print and a known print in this case?
A. Yes, I did.
Q. What did you determine at the analysis stage?
A. I received a gun found at the crime scene. Processing that evidence revealed one latent fingerprint that was suitable for comparison.
Q. What did you do next?
A. Next, I compared this fingerprint to the known fingerprints taken from the defendant on an inked card.
Q. What did you conclude?
A. I identified the latent print as having come from the same source.
Q. Is there a term for that?
A. Yes, it is called a source identification.
Q. Can you explain what that means?
A. Yes. It is the conclusion that the impressions originated from the same source. This conclusion is an examiner's decision that the observed features are in sufficient correspondence such that the examiner would not expect to see the same arrangement of features repeated in an impression that came from a different source and insufficient features in disagreement to conclude that the impressions came from different sources.
Q. So it is a strong conclusion?
A. Yes. A conclusion of source identification means that I believe that the probability that the two impressions were made by different sources is so small that it is negligible.
Q. Was there a verification?
A. Yes. My results were confirmed by another examiner.
Q. Thank you.

<u>Prosecution Fingerprint Expert Testimony: Inoculation Addition</u>

Q. Does a source identification mean that there is no chance that an error can occur?

A. Of course not. Every scientific method has some degree of uncertainty when used in practice. There have been only a very small number of errors in real cases that have come to light in latent fingerprint work. There have been studies of error rates in fingerprint examination as well. I have concerns about how realistic those studies were and how well they were designed. Regardless, if you read those studies correctly, they show that error rates are very low. I am confident in this case that the prints originated from the same source.
Q. Thank you.

Defense Fingerprint Expert Testimony: Methodological Rebuttal

Q. Good afternoon.
A. Good afternoon.
Q. Can you please introduce yourself to the jury?
A. Yes. My name is David Smith.
Q. How are you employed?
A. I work at the state college.
Q. And do you have a particular duty or title?
A. I am a professor in the forensic science program.
Q. How long have you been employed there?
A. For 3 years.
Q. And prior to your employment at the state college, were you employed elsewhere?
A. Yes.
Q. Where?
A. The state crime lab.
Q. What was your title there?
A. Latent fingerprint examiner.
Q. How long were you employed there?
A. Ten years.
Q. What was the description of that job?
A. I examined latent fingerprints and compared them to known prints.
Q. Prior to your employment there, were you employed elsewhere?
A. Yes.
Q. Where?
A. At the Federal Bureau of Investigation.
Q. What was your work there?
A. I was trained in fingerprinting and worked as a fingerprint examiner for two years.
Q. Did you overlap with the prosecution expert in this case?
A. Yes, during some of that time.
Q. You were colleagues?
A. Yes.
Q. Did you work well together?
A. Yes, we always did.
Q. Since your time at the state crime lab, have had additional training in fingerprinting?
A. Yes. I attend conferences and trainings regularly.
Q. Are you a member of any professional organizations?
A. Yes. I am a member of the International Association for Identification.

Q. Over the course of your years at the state crime lab, approximately how many latent fingerprint examinations and comparisons have you conducted?
A. Probably 400,000 comparisons.
Q. Is there an error rate in fingerprint work?
A. Of course. Any human task has an error rate. For many years, though, no one had studied it in the fingerprinting field.
Q. Has the error rate been measured?
A. Yes. There have been just two valid studies of the error rate in fingerprinting.
Q. What did they conclude?
A. Both studies were of something called an "upper bound" on the rate of errors in fingerprint comparisons based on scientific testing. One study's estimate was given as "1 in 306," and the other study's estimate was given as "1 in 18." The "upper bound" of these false positive rates means that based on the studies, the error rates for a conclusion like the one you heard could be as high as 1 in 306, according to one study, or 1 in 18, according to the other.
Q. How can those errors occur?
A. Any time you are comparing latent fingerprints to known prints from a person, you are comparing detailed patterns based on your own judgment. Good prints can have a great deal of information. The problem is that latent prints can be missing a great deal of information. They can be distorted or smudged. You may have to make inferences. And there is no set number of points or similarities that you have to find to conclude that it is an identification. Every examiner has their own standard.
Q. So is it a subjective method?
A. Fingerprint work is subjective. You have to make judgment calls. Sometimes you can be very confident that you have it right, but there is no way that you can be sure.
Q. Have fingerprint examiners made errors in the past?
A. Yes, of course, including in some very high-profile cases, where fingerprint examiners erroneously matched evidence to people who were later determined to be innocent.
Q. Have you examined the latent fingerprints in this case?
A. No, I have not had an opportunity to do that.
Q. Thank you.

<u>Defense Fingerprint Expert Testimony: Inconclusive Comparison Addition</u>

Q. Have you examined the latent fingerprint in this case?
A. Yes, I did.
Q. What did you conclude about it?
A. I found it to lack sufficient detail to make it suitable for comparison. The latent print was an extremely poor quality partial print that should not be used as a basis for a conclusion about identity.
Q. So does that mean that a fingerprint examiner cannot reasonably determine who left that print at the crime scene?
A. Correct. The print recovered from the crime scene is simply not good enough to use to make an identification.

<u>Defense Fingerprint Expert Testimony: Exclusion Addition</u>

Q. Have you examined the latent fingerprint in this case?
A. Yes, I did.
Q. What did you conclude about it?
A. I compared it to the known prints from the defendant. I concluded that the defendant was not the source of the latent print recovered from the crime scene.
Q. What does that mean?
A. It means that in my opinion the defendant's fingerprints do not match the latent fingerprint found on the handle of the gun recovered from the crime. Someone else is the source of that fingerprint.
Q. Thank you.

Table 1: Tukey HSD Tests of Pairwise Comparisons of Effect of Control and Expert Testimony Conditions on the Likelihood Defendant Committed the Crime Dependent Variable

Trial Condition 1	Trial Condition 2	Mean Difference (Condition 1- Condition 2)	Standard Error	*p* Value	95% Confidence Interval
Control (*n* = 82)	Prosecution Expert Only	-29.50	2.99	.00	-37.67, -21.34
	Prosecution Expert v. Method Rebuttal	-18.85	2.99	.00	-27.01, -10.68
	Prosecution Expert v. Inconclusive Rebuttal	-8.41	2.99	.04	-16.58, -.25
	Prosecution Expert v. Exclusion Rebuttal	-4.10	2.99	.65	-12.27, 4.06
Prosecution Expert Only (*n* = 409)	Control	29.50	2.99	.00	21.34, 37.67
	Prosecution Expert v. Method Rebuttal	10.66	1.73	.00	5.94, 15.38
	Prosecution Expert v. Inconclusive Rebuttal	21.09	1.73	.00	16.37, 25.881
	Prosecution Expert v. Exclusion Rebuttal	25.40	1.73	.00	20.68, 30.12
Prosecution Expert v. Method Rebuttal (*n = 408)*	Control	18.85	2.99	.00	10.68, 27.01
	Prosecution Expert Only	-10.66	1.73	.00	-15.38, 5.94
	Prosecution Expert v. Inconclusive Rebuttal	10.43	1.73	.00	5.71, 15.15
	Prosecution Expert v. Exclusion Rebuttal	14.74	1.73	.00	10.02, 19.47

Prosecution Expert v. Inconclusive Rebuttal (n = 409)	Control	8.41	2.99	.04	.25, 16.58
	Prosecution Expert Only	-21.09	1.73	.00	-25.81, -16.37
	Prosecution Expert v. Method Rebuttal	-10.43	1.73	.00	-15.15, -5.71
	Prosecution Expert v. Exclusion Rebuttal	4.31	1.73	.09	-.41, 9.03
Prosecution Expert v. Exclusion Rebuttal (n = 408)	Control	4.10	2.99	.65	-4.06, 12.27
	Prosecution Expert Only	-25.40	1.73	.00	-30.12, -20.68
	Prosecution Expert v. Method Rebuttal	-14.74	1.73	.00	-19.47, -10.02
	Prosecution Expert v. Inconclusive Rebuttal	-4.31	1.73	.09	-9.03, .41

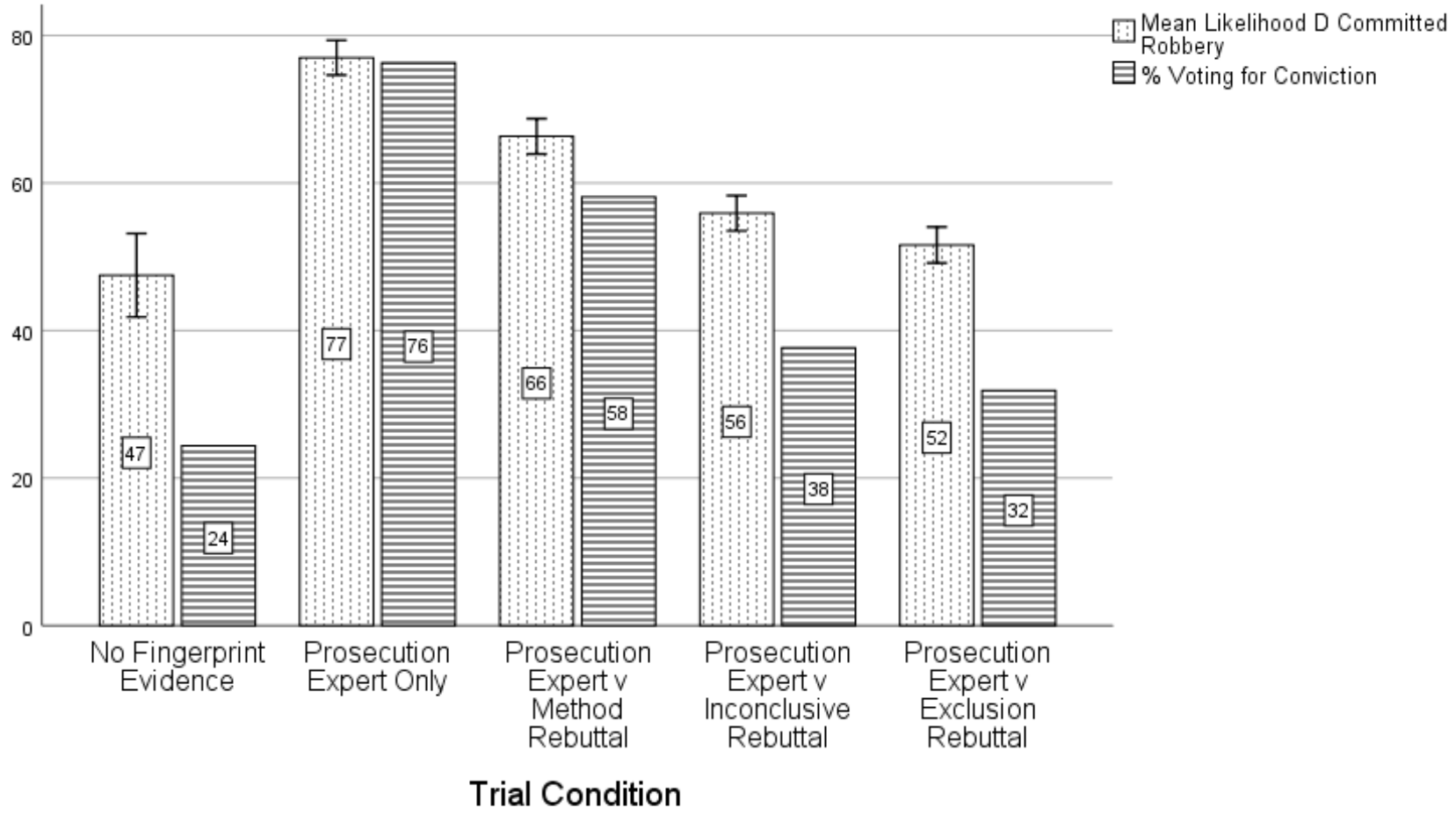
NOTE: Participants estimated the likelihood that the defendant committed the crime of robbery on a 0 - 100 scale.

Table 2: Pairwise Chi-Square Comparisons of Effect of Control and Expert Testimony Conditions on the Convict or Acquit Dependent Variable, with Bonferroni Correction Applied

		Trial Condition					
Vote to Convict?		Control	Prosecution Expert Only	Prosecution Expert v. Method Rebuttal	Prosecution Expert v. Inconclusive Rebuttal	Prosecution Expert v. Exclusion Rebuttal	Total
No	Count (%)	62 (75.6)[a]	97 (23.7)[b]	171 (41.9)[c]	255 (62.3)[a]	278 (68.1)[a]	863 (50.3)
	Adjusted Residual	4.7	-12.3	-3.9	5.6	8.3	
Yes	Count (%)	20 (24.4)	312 (76.3)	237 (58.1)	154 (37.7)	130 (31.9)	853 (49.7)
	Adjusted Residual	-4.7	12.3	3.9	-5.6	-8.3	

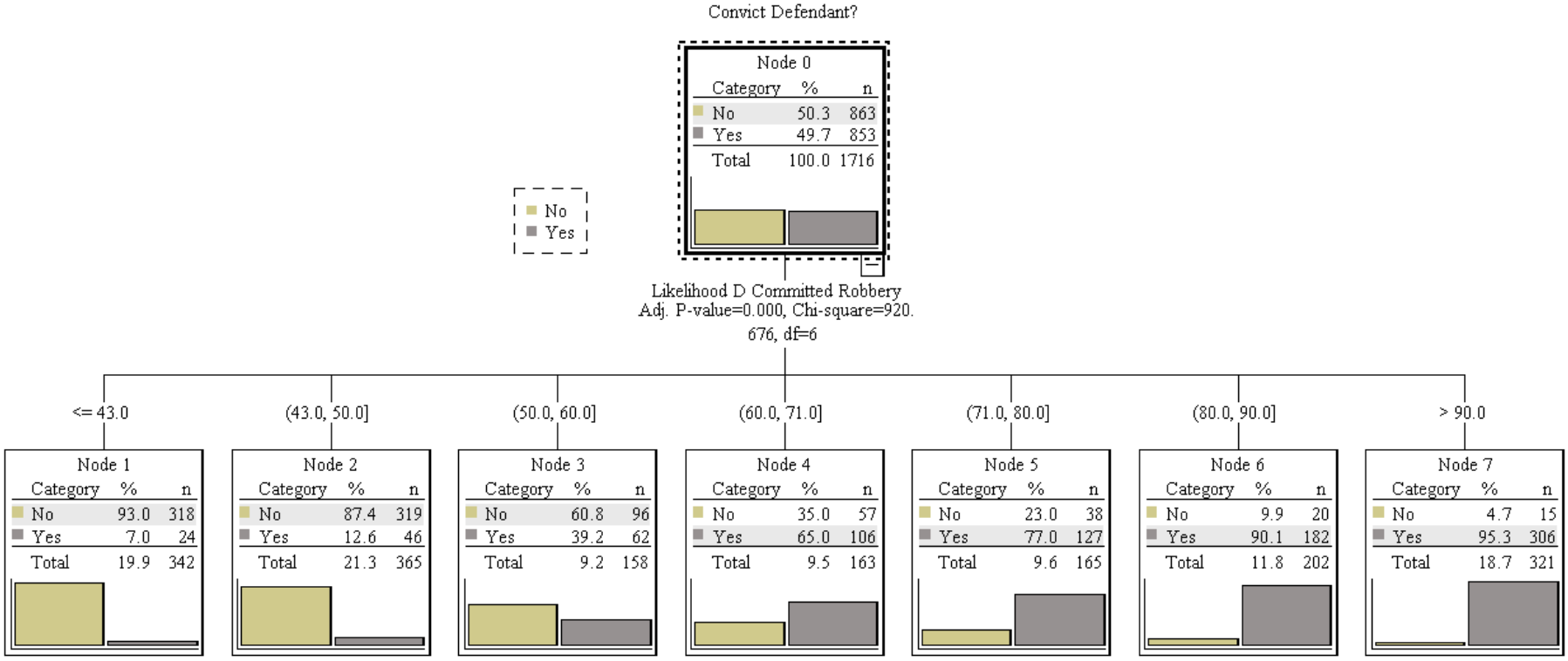
NOTE: Conditions sharing the same superscript in the "No" Count row do not differ significantly from each other at the .05 level.

Figure 1: Perceptions of guilt by trial condition



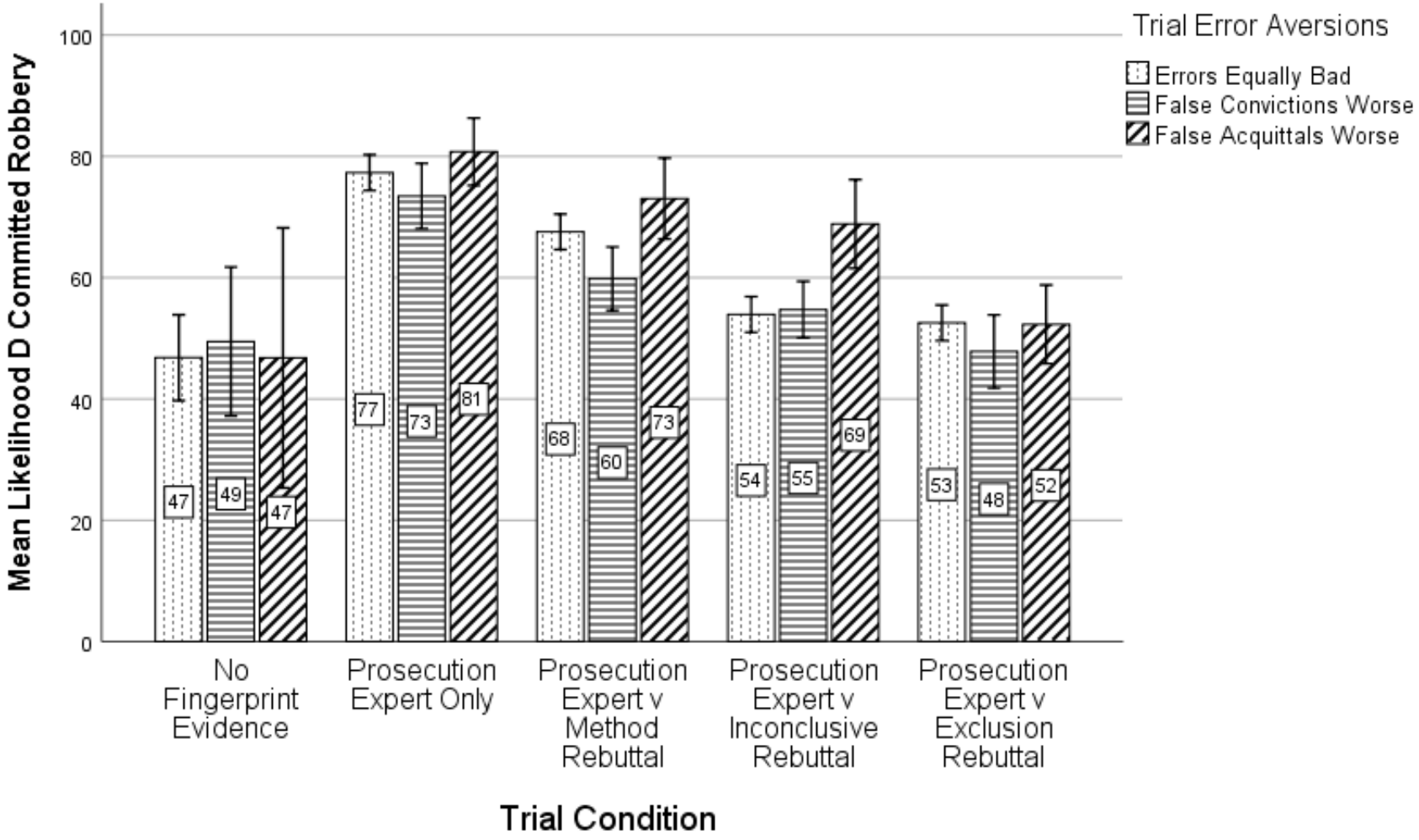
NOTE: Mean estimates of the likelihood that the defendant committed the charged crime (error bars reflect 95% confidence intervals) and percent voting for conviction across the different trials.

Figure 2: Decision tree analysis of votes for conviction by likelihood defendant committed robbery



NOTE: CHAID decision tree analysis grouping votes for conviction according to estimates of the likelihood that the defendant committed the charged crime.

Figure 3: Perceptions of guilt by error aversions



NOTE: Mean estimates of the likelihood the defendant committed the charged crime by trial error aversion and trial condition (error bars reflect 95% confidence intervals).