2020

Effects of Different Types of Forensic Evidence on Arrest Probability: Toward a New Typology of Evidence

Morgan Steele
Fort Hays State University, mjsteele2@fhsu.edu

Recommended Citation
Steele, M.J. (2020). Effects of Different Types of Forensic Evidence on Arrest Probability: Toward a New Typology of Evidence. Criminology, Criminal Justice, Law & Society, 21(3), 17-38. https://ccjls.scholasticahq.com/article/18148-effects-of-different-types-of-forensic-evidence-on-arrest-probability-toward-a-new-typology-of-evidence

VOLUME 21, ISSUE 3, PAGES 17–38 (2020)

Criminology, Criminal Justice, Law & Society

CRIMINOLOGY, CRIMINAL JUSTICE, LAW & SOCIETY

E-ISSN 2332-886X
Available online at
https://scholasticahq.com/criminology-criminal-justice-law-society/

Effects of Different Types of Forensic Evidence on Arrest Probability: Toward a New Typology of Evidence

Morgan J. Steele

Fort Hays State University

ABSTRACT AND ARTICLE INFORMATION

Forensic evidence is an important component in criminal justice decision-making. Yet, few studies have examined the effectiveness of the various macro-types of forensic evidence in facilitating arrest. This article analyzed over 4000 case files from five cities to determine how the collection and analysis of three macro-types of forensic evidence (Classification, Identification, and Progenitor) affect the probability of arrest across five different crime types. The results of several sets of logistic regression analyses suggest that forensic evidence affects the probability of arrest, but that the impact is not consistent across different types of crime or macro-types of forensic evidence. These findings suggest that the standard practice of dichotomizing forensic evidence collection to determine its effectiveness obscures how the macro-types of forensic evidence correlate with the odds of arrest differently across crime types.

Article History:

Received January 1st, 2020
Received in revised form July 16th, 2020
Accepted July 23rd, 2020

Keywords:

decision-making, forensic evidence, criminal investigation

Corresponding author: Morgan J. Steele, Department of Criminal Justice, Fort Hays State University, 600 Park Street – Rarick Hall Rm 233, Hays, KS, 67601, United States.
Email: mjsteele2@fhsu.edu

Forensic evidence is a key component of criminal investigations, providing more information and becoming more in-demand as our technology improves (Kiely, 2001; National Research Council, 2009). Indeed, prosecutors may be leery of cases that lack forensic evidence, as its usefulness becomes public knowledge (Baskin & Sommers, 2010a). However, analyses of the influence of forensic evidence on case outcomes often rely on a single indicator for forensic evidence collection (Baskin & Sommers, 2010b, 2011, 2012; Johnson et al., 2012; Peterson et al., 2013) or explore how a single type of evidence, such as DNA, affects the outcomes of particular types of cases (Campbell et al., 2009; Roman et al., 2009). In doing so, these analyses can obscure how different categories of forensic evidence affect criminal justice decision-making. This article explores how the collection and analysis of different categories, or macro-types, of forensic evidence affects the likelihood of arrest.

The macro-types of forensic evidence categorize the items based on their role in the criminal investigation. This typology expands on the familiar dichotomy of *Classification* and *Identification* evidence by including *Progenitor*, or objects that are both potential sources of forensic evidence as well as of interest to investigators. *Classification* evidence are any type of fragmentary evidence recovered during the investigation that indicates a transfer of matter via Locard's Principle. These can be used to reconstruct the crime event to establish a narrative, to provide broad characteristics of the object, and to support or refute testimony. Crucially, *Classification* evidence cannot be used to positively identify someone at the scene. Next, *Identification* evidence includes unique biological (e.g., DNA) or physiological (e.g., fingerprints) samples capable of conclusively identifying an individual and associating them with a crime event or excluding them from the investigation. These two macro-types are familiar categories of forensic evidence, often used for training (Kiely, 2001). However, this dichotomy excludes an important category: discrete objects that can function as sources of multiple types of forensic evidence or as useful items of tangible evidence in their own right, which I am describing as *Progenitors* of forensic evidence. For example, a firearm recovered at the scene of a crime can be a source of both *Classification* and *Identification* evidence (i.e., ballistics and toolmark analysis and fingerprints). That firearm can also provide a serial number with which investigators can identify the original purchaser, which is useful itself.

Locard (1930) described a murder investigation in Germany that illustrates this typology well. Investigators collected hair, soil and plant samples, boot impressions, and blood from a beheaded woman found in the woods. Once they followed a trail to a nearby house, the investigators found a boot and a coat, which they were then able to compare to the samples recovered at the scene to associate an individual to the scene. With this information, the investigators were able to obtain a confession without knowing the suspect's motive or the victim's name. In this case, the investigation hinged on the evidence recovered at the scene (*Classification* evidence) and matched to objects in the suspect's possession (*Progenitor* evidence) that were discovered later. More recently, the police's use of DNA evidence proved to be the key factor in identifying the Golden State Killer (Guerrini et al., 2018). Using DNA (*Identification*) evidence recovered at crime scenes decades ago, investigators submitted genetic profiles to ancestry databases. From those databases, the police were able to identify likely family members, which enabled them to narrow their suspect pool to a particular individual. In this instance, the police were able to identify the suspect in multiple heinous crimes based on the forensic evidence he left behind.

By using these macro-types to study the impact of forensic evidence, criminologists can benefit in two important ways. First, relying on a simple dichotomous measure, such as "was any forensic evidence collected during the investigation," is likely to produce an invariant predictor. This is because investigations into serious crimes nearly always collect some form of forensic evidence (Baskin & Sommers, 2010b). With forensic evidence becoming a near-requirement for conviction in jury trials (Baskin & Sommers, 2010a), police are likely to feel compelled to collect forensic evidence in every case, even if the case is unlikely to be successful due to other factors. Consequently, the use of a single measure to represent whether forensic evidence is collected is unlikely to represent its true effect as it is too broad of a measure.

Additionally, researchers' use of a single predictor to represent whether any evidence was collected omits the possibility that investigators may collect evidence for differing purposes. In Locard's example case, investigators used the evidence recovered at the scene to reconstruct the route the perpetrator took from where he disposed of his victim's body to his home. In contrast, investigators of the Golden State Killer did not have a way to identify the perpetrator until they searched genealogical databases for a relative. In the first case, the *Classification* and *Progenitor* evidence was vital to the case, while the blood samples were unnecessary (indeed, impossible) to analyze. Conversely, the Golden State Killer's familial DNA match was the decisive missing piece to allow the police to narrow their suspect pool and identify the perpetrator (Guerrini et al., 2018).

Yet, most research into forensic science has focused on establishing new ways to collect and analyze evidence (Giannelli, 2006). One need only look to the research into forensic DNA analysis and computer forensics and the development of standards of scientific rigor to see this effort (Al Awadhi et al., 2015; Parsons et al., 2018; Wilson et al., 2010; Wilson-Wilde, 2018). More recent calls for research have tried to address the consistency and accuracy of the conclusions reached from the analysis of forensic evidence (Kafadar, 2015; National Research Council, 2009). However, these foci of improving the collection, analysis, and reliability of forensic evidence do not explore how that evidence is used in the criminal justice system. It is equally important to recognize when and how forensic evidence plays a role at each decision point in the criminal justice process.

This paper examines the relationship between the macro-types of evidence collected during a criminal case and the probability of arrest. Data across five crime types (homicide, rape, assault, robbery, and burglary) are analyzed to determine the effect of forensic evidence on the probability of arrest, net of other factors. The results are then discussed in light of their practical and methodological importance.

Literature Review

Role of Evidence in the Criminal Justice Process

Criminal cases move through a series of decision points in the criminal justice system, with actors at each point often considering different factors in their decision (Gottfredson & Gottfredson, 1988; Steffensmeier et al., 1998, among many others). Investigators make decisions based on the seriousness of the offense and the likelihood of a favorable outcome. The forensic evidence, usually in conjunction with testimony from the involved parties, provides investigators with information to assess both aspects of the case: seriousness and the likelihood of a good arrest. Broadly speaking, investigators gather forensic evidence in order to associate people, places, and objects to a particular event, as well as confirm or refute a victim, suspect, or witness's testimony. In doing so, the police use forensic evidence to provide three types of information: who was involved, what occurred, and whether those involved are telling the truth. This practice is based on Locard's Principle, which states that "all close physical contacts result in an exchange of trace amounts of matter, typically hairs, soils, and other trace evidence" (Kiely, 2001, p. 57). Every object collects small, pulverized pieces of the other objects and places they came into contact with and thus reproduces each contact (Locard, 1930). On its own, forensic evidence is largely useless as it requires investigators to infer what the evidence's presence in the investigation means for the case (Kruse, 2012) and may require some testimonial evidence to interpret. Thus, investigators may need extensive laboratory analysis to interpret the evidence, such as DNA sequencing to identify suspects or ballistic comparisons to associate bullets to firearms. Depending on the evidence gathered, investigators may have to send the evidence to state or federal laboratories, a process that takes months or even years to complete (King et al., 2017), whereas other types of evidence, such as product serial numbers, can often be analyzed much more quickly. Understanding both the utility of emerging and existing types of forensic evidence, as well as the costs in time and resources necessary to interpret that evidence, is one of the key challenges facing academics and practitioners going forward (Campbell et al., 2017).

Research into criminal justice decision-making has found that collecting physical evidence is useful in a variety of decision points, such as arrest and plea bargaining (Gottfredson & Gottfredson, 1988; Figueira-McDonough, 1985; Novak et al., 2002; Sun & Payne, 2004). However, this utility is often misunderstood, with police and forensic investigator trainees often taught that forensic evidence plays a determining role in criminal cases. This exaggerates its influence and can bias officers' understanding of how that evidence is used within the criminal justice system (Horvath & Meesig, 1998).

Effectiveness of Forensic Evidence across Different Crime Types

Despite these drawbacks, forensic evidence can be particularly useful in solving a wide variety of crimes (Bond, 2007; McEwen & Regoeczi, 2015; Roman et al., 2009). Several studies have found that the collection and analysis of forensic evidence is a significant predictor of arrest. An early study of this found that forensic evidence was most useful in cases where the victim was unable to identify the suspect (Peterson et al., 1984). In a follow-up study, Peterson and colleagues (2010) conducted a large-scale review of the effect of evidence on case results of five crime types (burglary, robbery, assault, rape, and homicide) in the United States. They found that cases where investigators collected forensic evidence were much more likely to lead to an arrest than cases without forensic evidence (Odds Ratio [*OR*] = 2.90). If the laboratory examined the evidence, the prosecutor was more likely to charge the defendant (*OR* = 4.13), and the defendant was more likely to be convicted at trial

(*OR* = 2.32; Peterson et al., 2010). These effects were fairly consistent across crime types when examined as a dichotomous measure. This is not the case when its influence is examined across crime types.

For instance, there is some ambiguity as to how useful forensic evidence is in the decision to arrest for burglaries. A study of burglaries and vehicle thefts in Great Britain reported that DNA collected during the case had a significant effect on the probability of identifying a suspect. Mobile samples (e.g., saliva from a cigarette) were less likely than non-mobile (e.g., a drop of blood at a scene) to lead to the identification of a suspect (Bond, 2007). In Roman and colleagues' (2009) study of property crimes, the analysis of forensic DNA evidence increased the likelihood of identification by 18%, compared to cases where investigators found but did not analyze DNA evidence, with nearly a 12% increase in arrests relative to cases where no DNA evidence was found. Conversely, Baskin and Sommers' (2011) analysis of burglary cases indicated that reports by victims and witnesses (*OR* = 9.34, *OR* = 3.22) were much stronger predictors of arrest than forensic evidence (*OR* = 3.11).

Forensic evidence also seems to play a role in the police's effectiveness at solving robbery and assault cases (Baskin & Sommers, 2012). Assault cases including physical evidence were twice as likely to lead to an arrest (*OR* = 2.03), and robberies with forensic evidence were over five times as likely (*OR* = 5.30). The authors argued that forensic evidence may have a stronger effect than indicated, but it could be obscured by situational factors, such as the presence of witnesses, the severity of the incident, or the victim's relationship with the suspect.

In more severe crimes such as homicide and sexual assault, forensic evidence also appears to be essential to the arrest of suspects. Johnson and colleagues (2012) reported that evidence recovered during the investigation increased the odds of arrest in sexual assault cases by 150% (*OR* = 2.51). The analysis of evidence was also a strong predictor of arrests in these cases, increasing the odds of arrest by 63%. Forensic evidence collected by medical staff had a significant positive effect on the probability of the case moving through the criminal justice system (Campbell et al., 2009). This study analyzed the effect of evidence collected by forensically trained medical professionals on case outcomes. Medical forensic evidence in these cases was most beneficial when collected as soon after the assault as possible. They also found that two specific types of medical forensic evidence, the examiner finding anogenital redness and their collecting the suspect's DNA, were positively associated with the case progressing through the system. This suggests that specific types of forensic evidence affect the case outcome differently. Campbell and colleagues (2009) also suggest that the amount of time that passes between the victimization and investigators collecting evidence affects the strength of the evidence's impact.

In homicides, forensic evidence had the potential to be even effective at leading to arrest, but this effect was not consistent (*OR* = 3.45 but not significant at 0.05; Baskin & Sommers, 2010b). This inconsistency may be due to investigators in nearly all homicide cases collecting some type of forensic evidence, minimizing any effect of forensic evidence on the odds of arrest. Moreover, the type of evidence also influenced the odds of arrest in unique ways. First and most surprisingly, DNA evidence rarely affects the odds of arrest in homicide cases in a reliable way. Schroeder and White (2009) evaluated nearly 600 homicide cases to determine whether DNA evidence affected case clearance rates. They found that detectives rarely used DNA evidence, oftentimes submitting it for testing when they ran out of other investigative leads. Indeed, the authors suggested that investigators would often collect DNA evidence to help prosecutors at trial, rather than to clear the case. A later analysis by McEwen and Regoeczi (2015) supported Schroeder and White's (2009) conclusion by finding that DNA evidence was negatively associated with arrest probability in homicide cases.

Ballistic evidence, such as bullet casings and firearms, has little discernable impact on violent crime case outcomes (King et al., 2017). They explored how the analysis of ballistic evidence through the National Integrated Ballistics Information Network (NIBIN) affected criminal case processing. King and colleagues (2017) found that the NIBIN reports were rarely used because they seldom contained useful information to aid investigators and those reports often arrived too late to contribute to the investigation. The information contained within the reports often necessitated additional research by the investigators, especially if an individual used a firearm across multiple jurisdictions.

While forensic evidence can have a different effect on decision-making based on the crime type, as discussed by Roman et al. (2009), Schroeder and White (2009), and King et al. (2017), the effect may also change based on the type of evidence collected. As Kiely (2001) described, there are two basic categories of forensic evidence, *Classification* and *Identification,* which are used to reconstruct crime scenes and identify suspects, respectively. By only categorizing evidence into these two groups, however, researchers omit an important kind of physical evidence, objects that can be sources of multiple types of evidence. Thus, this article proposes that there are three macro-types of forensic evidence: *Classification*, *Identification*, and *Progenitor*. The *Progenitor* macro-type of forensic evidence would perform two important functions for this type of analysis. First, it would capture instances where objects like articles of clothing, weapons, and documents could yield a variety of other types of forensic evidence (e.g., hair/fiber samples, ballistic evidence, fingerprints, etc.). In the murder in Germany described above, investigators collected *Classification* evidence from the scene of the murder and associated that evidence with the murderer's clothes and boots, which were progenitors of additional *Classification* evidence (Locard, 1930). The analyses of firearms from NIBIN discussed by King and colleagues (2017) included *Classification* and *Progenitor* evidence in the form of recovered bullets and spent cartridges as *Classification* and the recovered firearms as the *Progenitor*s of the comparisons, as well as potentially other pieces of evidence. Likewise, the comparisons of static and mobile DNA sources discussed in Bond (2007) exhibit a similar pattern, with the static DNA being a type of *Identification* evidence and the mobile sources, like cigarette butts, being *Progenitors* of both DNA and other evidence. In the Atlanta child murders case, carpet and pet hair fibers that investigators collected from murder victims (i.e., *Classification* evidence) in Atlanta provided information necessary to identify Wayne Williams as a suspect, which was later confirmed after testing his home and vehicle for matches from *Progenitor* samples (Kiely, 2001). In these cases, investigators collected *Classification* evidence from the scene, which they were able to associate with the *Progenitors* of that evidence. This is an important distinction because if one were to find that, say, *Classification* evidence increases the probability of arrest more so than *Progenitor* evidence, then criminal justice personnel could align their policies to better allocate resources to the collection of *Classification* evidence in hopes of increasing clearance rates.

Second, it would also account for instances where the object itself provides important information without forensic analysis, such as a receipt associating an individual with a location or a firearm's serial number. This is especially relevant to burglary and robbery cases, as finding an individual who has the stolen property in their possession would likely be cause enough to arrest them. *Progenitor* evidence would also be useful in more serious crimes, such as finding a knife in the possession of an assaulter or murderer. In these cases, these items could also be sources of toolmark and fingerprint evidence.

Additionally, these macro-types of forensic evidence may play a different role in how police and court officials make decisions. As noted above, homicide investigators only rely on DNA evidence when they lack the leads necessary to identify a suspect and collecting DNA is associated with a decrease in the likelihood of arrest (McEwen & Regoeczi, 2015; Schroeder & White, 2009). King and colleagues' (2017) finding concerning ballistic evidence and recovered firearms reinforces this. However, the remaining studies discussed above consistently found that investigators' collection of forensic evidence often affects the probability of arrest across offense types, though not always to the level of statistical significance (Baskin & Sommers, 2010b, 2011, 2012; Bond, 2007; Campbell et al., 2009; Johnson et al., 2012; Peterson et al., 1984; Roman et al., 2009). Building on these conflicting studies, it is possible that while forensic evidence as a whole is a positive predictor of arrest, the different macro-types of forensic evidence affect that decision differently across crime types.

In short, what researchers and practitioners need now is comparative information about the relative efficacy of the three macro-types of forensic evidence on arrest rates. Understanding if and how the three macro-types affect the likelihood of arrest differently, consistently or across crime types, can provide valuable information to guide future analyses of the influence of forensic evidence on criminal justice decisions. Thus, the present study will explore the relationship between the type of forensic evidence collected at a crime scene and the probability of arrest for that crime. Specifically, the research question of focus is whether the likelihood of arrest is contingent on the type of forensic evidence collected. This study will also examine how indications of the practical constraints of the investigation, specifically forensic evidence as well as other relevant factors, affect the likelihood of arrest across offenses. This will show whether and to what extent the effects of the macro-types of forensic evidence vary as a function of the crime in question.

Method

Sample & Data Collection

This analysis draws data from the study titled "Impact of Forensic Evidence on the Criminal Justice Process in Five Sites in the United States, 2003-2006," which is available on ICPSR (Peterson & Sommers, 2010). Originally, Peterson and Sommers (2010) selected three study sites to gather data on the effectiveness of city, county, and state crime labs. They obtained a random sample of reported criminal cases for five crime types: assault, burglary, homicide, rape, and robbery. They also oversampled homicide and rape cases as these cases were more likely to include forensic evidence than the other three categories (Peterson & Sommers, 2010). However, due to limitations in the homicide data,[1] those cases were excluded from some of the analyses presented below. The unit of measurement for this study is the crime incident.

The database was comprised of 4205 official records from police reports for the investigation, reports from the crime labs, and the court case files. These data sources were included to provide case descriptions and assess the impact of the forensic evidence on criminal justice outcomes. Since Peterson and Sommers (2010) used completed criminal case records, there were no missing data issues. Unfortunately, information about the timing of evidence collection during the investigation was not included in the dataset, precluding assessments of causality.

The study sites were Los Angeles County, CA; Indianapolis, IN; Fort Wayne, IN; Evansville, IN; and South Bend, IN (the latter three sites will be referred to as "the Three Cities"). For Indianapolis and LA County, Peterson and Sommers (2010) collected a random sample of case data from 2003, stratified by crime type. They selected 2003 as their time frame so that all the relevant case data could be included. For the three smaller Indiana sites, they collected case data from 2003-2006 in order to include enough cases for the data set to be useful.

The largest crime category in the study is burglary ($n = 1263$), which comprises 30% of all cases, followed by robbery ($n = 1081$, 25.7%), assault ($n = 859$, 20.4%), rape ($n = 602$, 14.3%), and homicide ($n = 400$, 9.5%). LA County had the largest number of cases (41%), with Indianapolis and the three other cities accounting for over 29% each. There are substantial differences between the crime types across cities ($X^2 = 215.42$, $p = <0.001$). When looking into the crime categories across sites, several important points became apparent. Los Angeles County has over 60% of the homicides in the data set and nearly half of the robberies, yet it only accounted for 40% of the total cases in the sample. Interestingly, LA County had only a quarter of the total assault cases, while Indianapolis and the Three Cities had over 35% each. However, this may be a function of the relative differences in the populations across the three site categories as indicated by the moderate relationship shown by Cramer's V ($V = 0.160$, $p = <0.001$). This significant difference in crime type and amount across the three sites sampled for this dataset will be accounted for through control variables in the statistical analyses.

The three sets of analyses described below extend the current understanding of the effects of forensic evidence on the initial outcomes of criminal investigations. The first set of analyses show how the collection of the three macro-types of forensic evidence affects the odds of arrest differently across crime types. The second set explores how combinations of those macro-types may influence the decision to arrest. The third set shows how the collection and analysis of forensic evidence macro-types affects the odds of arrest. Table 1 is a frequency table for all the measures described below.

Measures

Arrest

This study uses the dichotomous variable *Arrest* as the dependent variable. *Arrest* was coded as "0" for no arrest and "1" for arrest. The crime with the lowest proportion of arrests across the three sites was burglary, with an average of 8.2% of cases leading to arrest. Robbery had the next lowest arrest rate, with an average of 22.5% arrests. Rape, assault, and homicide cases had similar average arrest rate at 45%, 49.4%, and 55.5% respectively. In these data, burglary provides a useful comparison group because forensic evidence was not collected in most burglary cases and did not result in arrest.

Macro-Types of Forensic Evidence

The macro-types of evidence were differentiated into the three types, *Classification*, *Identification*, and *Progenitor*, based on the codebook description (Peterson & Sommers, 2010) and are more explicitly defined below. For a list of the individual evidence categories included within each macro-type, please see Appendix 1: Individual Evidence Collection Variables Assigned to Three Evidence Categories and Appendix 2: Individual Evidence Analysis Variables Assigned to Three Evidence Categories for evidence collected and analyzed.

Classification Evidence. The *Classification Evidence* variable was created as an index variable constructed from 33 dichotomous items in the dataset and as a dichotomous variable indicating that at least one type of *Classification* evidence was collected during the investigation ("0" = none collected, "1" = at least one was collected). Each contributing variable was selected based on the variable description in the database codebook. The *Classification Evidence* category describes how frequently investigators recovered minute traces and components of objects during the investigation. Items were categorized as *Classification* if the description said it was a sample of a larger object (such as a splinter of a doorframe) or if it was a component part of another object (e.g., a bullet recovered at the scene, which could be matched to a gun). The included evidence such as fired bullets, glass fragments, fabric, and soil samples.

Table 1: Frequencies of Measures

	Burglary Number (percent)	Robbery Number (percent)	Assault Number (percent)	Rape Number (percent)	Homicide Number (percent)	All Crimes Number (percent)
Arrest	104 (8.23)	243 (22.48)	424 (49.36)	271 (45.02)	222 (55.50)	1264 (30.06)
Forensic Evidence Types						
No Forensic Evidence Collected	1011 (80.05)	810 (74.93)	604 (70.31)	218 (36.21)	9 (2.25)	2652 (63.07)
Classification	101 (8.00)	156 (14.43)	224 (26.08)	287 (47.67)	383 (95.75)	1151 (27.37)
Identification	224 (17.74)	119 (11.01)	46 (5.36)	337 (55.98)	282 (70.50)	1008 (23.97)
Progenitor	112 (8.87)	162 (14.99)	199 (23.17)	269 (44.68)	351 (87.75)	1093 (25.99)
Only Classification	3 (0.24)	40 (3.70)	43 (5.01)	15 (2.49)	20 (5.00)	121 (2.88)
Only Identification	96 (7.60)	61 (5.64)	6 (0.70)	89 (14.78)	1 (0.25)	253 (6.02
Only Progenitor	12 (0.95)	38 (3.52)	23 (2.68)	2 (0.33)	2 (0.50)	77 (1.83)
Classification & Progenitor	13 (1.03)	74 (6.85)	143 (16.65)	30 (4.98)	87 (21.75)	347 (8.25)
Classification & Identification	41 (3.25)	8 (0.74)	7 (0.81)	11 (1.83)	19 (4.75)	86 (2.05)
Identification & Progenitor	43 (3.40)	16 (1.48)	2 (0.23)	6 (1.00)	5 (1.25)	72 (1.71)
All Forensic Evidence Types	44 (3.48)	34 (3.15)	31 (3.61)	231 (38.37)	257 (64.25)	597 (14.20)
Analysis of Classification	5 (0.4)	50 (4.62)	80 (9.31)	91 (15.11)	345 (86.25)	571 (13.58)
Analysis of Identification	161 (12.75)	104 (9.62)	29 (3.38)	173 (28.74)	244 (61.00)	711 (16.91)
Analysis of Progenitor	6 (0.48)	34 (3.15)	47 (5.47)	80 (13.29)	229 (57.25)	396 (9.42)
Situational Factors						
Taken for Treatment	0 (0.00)	69 (6.380	270 (31.43)	411 (68.27)	251 (62.75)	1001 (23.81)
Witness Report	59 (4.67)	481 (44.50)	284 (33.06)	69 (11.46)	268 (67.00)	1161 (27.61)
Suspect Apprehended in 10 Minutes	34 (4.67)	101 (9.34)	257 (29.92)	64 (10.63)	59 (14.75)	515 (12.25)
Known Suspect	155 (12.27)	76 (7.03)	448 (52.15)	474 (78.74)	112 (28.00)	1265 (30.08)
Demographics						
Victim Non-White	463 (36.66)	603 (55.78)	479 (55.76)	208 (34.55)	325 (81.25)	2078 (49.42)
Suspect Non-White	115 (9.11)	876 (81.04)	437 (50.87)	295 (49.00)	270 (67.50)	1993 (47.40)
Male Victim	653 (51.70)	721 (66.70)	593 (69.03)	0 (0.00)	342 (85.50)	2309 (54.91)
Male Suspect	1216 (96.28)	1006 (93.06)	742 (86.38)	602 (100.00)	379 (94.75)	3945 (93.82)
LA County	489 (38.72)	528 (48.84)	230 (26.78)	231 (38.37)	245 (61.25)	1723 (40.98)
Indianapolis	350 (27.71)	335 (30.99)	323 (37.60)	150 (24.92)	71 (17.75)	1229 (29.23)
Other City	424 (33.57)	218 (20.17)	306 (35.62)	221 (36.71)	84 (21.00)	1253 (29.80)
Total	1263 (30.04)	1081 (25.71)	859 (20.43)	602 (14.32)	400 (9.51)	4205 (100)

Identification Evidence. The *Identification Evidence* variable included evidence that could positively identify a person using forensic evidence only. It is a composite variable of 14 dichotomous variables that indicated if investigators collected the focal evidence type. The resulting variable was dichotomized (“0” = none collected, “1” = at least one was collected) to show if the case included any of the 14 types of *Identification* evidence. These contributing variables are biological in nature and include fingerprints, sexual assault kits, and various potential sources of DNA (e.g., blood, feces, semen, etc.). This avoids the issue that Bond (2007) identified when determining the effectiveness of discrete samples of DNA (e.g., blood drops) compared to samples from other objects, such as from clothing, by including discrete samples of *Identification* evidence into their own category. The *Identification* category seeks to measure the effectiveness of collecting evidence capable of identifying a single individual on its own, without it being a part of any other piece of evidence.

Progenitor Evidence. The third type of evidence included as an independent variable is *Progenitor Evidence*. It consists of discrete objects that may present multiple opportunities for forensic and traditional investigation. This category of evidence comprises 23 categories representing objects such as weapons, drugs, vehicles, or clothing. The variable was dichotomized ("0" =none collected, "1" = at least one was collected) to show if the case included any of the 23 types of *Progenitor* evidence. *Progenitor* evidence can be useful without considering the forensic context, such as a gun registered to a particular individual or a receipt showing a purchase time. This evidence type can also provide important information through forensic analysis, such as when investigators collect a firearm to test against a recovered bullet. Investigators can collect additional evidence from the *Progenitor* evidence, such as collecting hair from clothing, or by comparing a sample taken from an item to one taken from a crime scene (e.g., matching clothing fibers found at the scene to a suspect's jacket). For the models, any *Classification* or *Identification* evidence recovered from a *Progenitor* piece of evidence would be counted in their respective categories, rather than being ignored or miscounted.

Combinations and Analysis of Forensic Evidence. It is also important to consider how combinations of forensic evidence affect the likelihood of arrest. Therefore, dichotomous terms were created for each unique combination of evidence types: *Classification and Progenitor, Classification and Identification*, *Progenitor and Identification*, and *All Forensic Evidence Types*. Three dichotomous variables were also created to indicate whether a case had only one type of forensic evidence: *Only Classification, Only Progenitor*, and *Only Identification*. For the regression analyses, three predictors were excluded across two of the models for having too few cases to effectively model. For the homicide model, *Only Identification* and *Only Progenitor* were excluded, with *Only Classification* excluded from the burglary model.

Analysis of Macro-Types of Forensic Evidence.

To determine the effect that submitting forensic evidence for laboratory analysis has on the likelihood of arrest, three additional dichotomous variables were created. These analysis variables used the same categorization and coding as the collection variables, with an *Analysis of Classification*, *Identification*, and *Progenitor* evidence categories included in a third set of regression models to show the effect of analysis of forensic evidence on the odds of arrest, net of other factors. The specific categories included in the creation of the analysis of forensic evidence measures is included in Appendix 2.

Control Variables

Several variables were included in the statistical models to account for situational and demographic factors identified in prior literature that could have affected the decision to arrest or the investigator's ability to collect forensic evidence. Some factors, such as whether the victim was taken for treatment, could alter the investigator's perceptions of the seriousness of the offense, which could then affect the amount of evidence they collect. Other factors, such as whether the suspect was apprehended within ten minutes of the incident, could affect the officers' perception of whether forensic evidence was needed in that case. The crime type and case location were controlled for to account for offense seriousness, the differences in investigatory procedure across the study sites, and the perception of need for forensic evidence for each crime type. The suspect and victim demographic characteristics were included to account for any differences in evidence collection for minority-involved cases compared to Caucasian males.[2]

Studies using the same dataset also controlled for several situational and demographic factors (Baskin & Sommers, 2011, 2012; Johnson et al., 2012; Peterson et al., 2013). For example, cases in which witnesses reported the crime may affect how much forensic evidence the investigators feel they need to collect. Controlling for the suspect and victim's race and sex would account for any racial and gender biases that could affect evidence collection and how much the police are willing to work to arrest the perpetrator. Other control variables represented situational factors, such as crime type, whether the officer apprehended the suspect at the scene, and the victim's familiarity with the suspect. For instance, if the victim could identify the suspect, investigators might not perceive a need to collect *Identification* evidence to support the case. Most of the control variables were simple dichotomous variables ("0" = no, "1" = yes) to indicate whether something occurred. Crime type was also converted into five dichotomous variables from the original ordinal scale for ease of interpretation. The study site variable was also dichotomized to account for differing procedures, resources, and local crime trends that are specific to each locale.

Analytic Plan

This study used logistic regression to test how the three macro-types of evidence affected the likelihood of arrest, net of demographic and situational factors. This was accomplished using Stata version 15.1. For the models including all crime types, weighted logistic regression was used to account for the different sample sizes within each crime type. The three sets of weighted and unweighted models of the effects of forensic evidence on all crimes are presented separately in Appendix 3, with the weighted models included in Tables 2-4. I assessed for multicollinearity by examining the variance inflation factor (VIF) values for the predictor and control variables for disaggregated crime types and for the models considering the effects of forensic evidence overall. Broadly speaking, multicollinearity was not an issue across the models. However, several variables had VIF values above 10 and are noted below. The possibility of influential cases was assessed using the Cook's Distance values, with no case across the 17 regression models having a value of one or more. Thus, all cases were included in the models. However, factors that may have influenced forensic evidence collection, such as whether investigators were involved in multiple cases within the dataset or the type of location (e.g., residence, car, outdoors, street, etc.) could not be accounted for in the following analyses.

Results

Presence of Forensic Evidence across Crime Types

Table 2 shows how the likelihood of arrest is expected to change as police collect different types of forensic evidence, disaggregated by crime type. Note that homicides were excluded from the crime type-specific analysis because preliminary analyses and previous reports by Baskin & Summers (2010b) revealed that 97% of homicide cases collected at least one type of forensic evidence. It is also important to note that the omitted category here is *no forensic evidence.* Additional sensitivity tests were conducted to determine if specific evidence types were better than others were. However, the relationships were nearly identical in statistical significance, strength, and direction to those shown by the comparisons against no forensic evidence. Thus, all the coefficients for the forensic evidence variables reveal the impact on the odds of arrest for *that* type of evidence versus having no forensic evidence. To account for the difference in sample sizes within each crime type, a weighted binary logistic regression model is used, with the weights created via the p-weight command in Stata. The standard errors presented in the weighted model are robust standard errors.

When all the crime types are included in the weighted logistic regression model, *Progenitor* evidence has a strong and consistent positive effect on the odds of arrest (OR = 1.5927, p = 0.023), with *Classification* evidence having a slightly weaker, but insignificant effect (OR = 1.4820, p = 0.055). Several of the situational control variables are also significant predictors of arrest: whether the victim was taken for treatment (OR = 1.4478, p = 0.026), if the police apprehended the suspect at the scene (OR = 65.3462, p < 0.001), the victim-suspect relationship (OR = 3.2497, p < 0.001), and the location of the crime[3] (Los Angeles OR = 3.4496, p < 0.001; Indianapolis OR = 3.3561, p < 0.001) all had strong effects on the odds of arrest.

Forensic evidence was ineffective in the outcome of rape cases, with none of the evidence categories having a statistically significant effect on the odds of arrest. The situational case characteristics, however, all significantly increased the odds of arrest. Whether the victim sought medical treatment (OR = 2.5831, p < 0.001), the police apprehended the suspect at the scene (OR = 28.6076, p < 0.001), and if the victim knew the suspect strongly (OR = 4.9760, p < 0.001) consistently increased the odds of arrest. Somewhat less consistently, whether a witness reported the rape (OR = 2.4431, p = 0.012) also had a strong effect.

Forensic evidence also did not influence the odds of arrest for assault cases, with the positive effect of Identification evidence having a strong, but inconsistent effect (OR = 2.1772, p = 0.070). The only consistent predictors of arrest were whether the police apprehended the suspect soon after the crime (OR = 98.2410, p < 0.001), if the assault occurred between acquaintances (OR = 2.7643 p = 0.002), and whether the victim or suspect was a racial minority (Victim OR = 0.4142, p < 0.001; Suspect OR = 1.6642, p = 0.014). Surprisingly, seeking medical treatment after an assault had a strong negative effect on the odds of arrest (OR = 0.4948, p = 0.003). The police were also much more likely to arrest someone for assault in LA County compared to the reference group of smaller Indiana cities (OR = 3.1759, p < 0.001).

Classification evidence is associated with an increase in the odds of arrest in robbery cases by over 110% (OR = 2.1110 p = 0.017), while the other types of forensic evidence did not have a strong effect. Consistent with the other crime types already reviewed, whether the police apprehended the suspect quickly (OR = 98.2410, p < 0.001) and if the victim and suspect knew each other (OR = 2.7643, p < 0.001) were both strong predictors of the odds of arrest. Robberies in Los Angeles were also much more likely to lead to an arrest (OR = 3.1759, p = 0.002), compared to the three smaller jurisdictions in Indiana.

Table 2: Effects of Forensic Evidence Collection on Arrest

Variable	All Crimes			Rape			Assault			Robbery			Burglary		
	b (se)	p	OR	b (se)	p	OR	b (se)	p	OR	b (se)	p	OR	b (se)	p	OR
Forensic Evidence															
No Forensic Evidence (reference)															
Classification	.3934 (.2048)	0.055	1.4820	0.0274 (.4469)	0.951	1.0278	.4539 (.2996)	0.130	1.5744	0.7471 (.3118)	0.017	2.1110	.8572 (.5464)	0.117	2.3565
Identification	-.0352 (.1667)	0.833	.9654	0.0814 (.2694)	0.763	1.0848	.7781 (.4298)	0.070	2.1772	-0.0268 (.3107)	0.931	0.9736	-0.8555 (.4445)	0.054	0.4251
Progenitor	.4654 (.2047)	0.023	1.5927	0.3498 (.4624)	0.449	1.4188	.3117 (.3091)	0.313	1.3657	0.4262 (.3104)	0.170	1.5314	1.6130 (.4758)	0.001	5.0178
Situational Factors															
Taken for Treatment	.3700 (.1667)	0.026	1.4478	0.9490 (.2437)	0.000	2.5831	-0.7035 (.2358)	0.003	0.4948	0.3681 (.3580)	0.304	1.4450			
Witness Report	.2693 (.1505)	0.074	1.3091	0.8933 (.3543)	0.012	2.4431	.1016 (.1865)	0.586	1.1069	-0.2014 (.2792)	0.471	0.8176	2.3348 (.3959)	0.000	10.3275
Suspect Apprehended in 10 Minutes	4.1797 (.2661)	0.000	65.3462	3.3537 (.6308)	0.000	28.6076	3.0209 (.2455)	0.000	20.5088	4.5874 (.4433)	0.000	98.2410	4.2930 (.7023)	0.000	73.1840
Victim – Suspect Relationship	1.1786 (.1488)	0.000	3.2497	1.6046 (.3005)	0.000	4.9760	.6098 (.2013)	0.002	1.8400	1.0168 (.3058)	0.001	2.7643	1.9969 (.3065)	0.000	7.3661
Crime Type															
Rape	1.0230 (.2222)	0.000	2.7815												
Assault	1.2991 (.1951)	0.000	3.6661												
Robbery	.8700 (.1848)	0.000	2.3870												
Demographics															
Non-White Victim	-0.1885 (.1278)	0.140	.8282	0.3890 (.2678)	0.146	1.4755	-0.8814 (.2143)	0.000	0.4142	-0.2409 (.2086)	0.248	0.7859	-0.2599 (.3189)	0.415	0.7711
Non-White Suspect	.0433 (.1365)	0.751	1.04430	-0.0120 (.2636)	0.964	0.9881	.5093 (.2065)	0.014	1.6642	-0.1844 (.2358)	0.434	0.8316	0.6707 (.4145)	0.106	1.9555
Male Victim	-0.1655 (.1355)	0.222	.8475				-0.4026 (.1975)	0.042	0.6686	-0.2536 (.1881)	0.178	0.7760	0.4331 (.2821)	0.125	1.5421
Male Suspect	-0.3190 (.2686)	0.235	.7269				-0.2194 (.2608)	0.400	0.8030	-0.2197 (.3375)	0.515	0.8028	-0.5550 (.4727)	0.240	0.5741
Location															
LA County	1.2383 (.1683)	0.000	3.4496	1.5247 (.2631)	0.000	4.5937	2.0473 (.2656)	0.000	7.7499	1.1556 (.3655)	0.002	3.1759	0.5264 (.3366)	0.118	1.6928
Indianapolis	1.2108 (.1670)	0.000	3.3561	3.0179 (.3144)	0.000	20.4487	.2755 (.2602)	0.290	1.3172	0.4594 (.2994)	0.125	1.5831	-1.0624 (.4307)	0.014	0.3456
Constant	-3.5239 (.3205)	0.000	.0295	-4.2394 (.4439)	0.000	0.0144	-1.1057 (.3653)	0.002	0.3310	-2.0401 (.4562)	0.000	0.1300	-3.3597 (.5664)	0.000	0.0348
N cases	3805			602			859			1081			1263		
Percent Correctly Classified	83.94%			76.74			78.23%			85.94%			94.22%		
Pseudo R^2	0.3184			0.3022			0.3274			0.2792			0.3977		

Forensic evidence also had a strong effect on the odds of arrest in burglary cases, with *Identification* and *Progenitor* evidence having strong effects. While *Progenitor* evidence had a strong positive effect on the odds of arrest (*OR* = 5.0178, p = 0.001), collecting *Identification* evidence had a substantial though inconsistent negative effect on the odds of arrest (*OR* = 0.4251, p = 0.054). Additionally, if a witness reported a crime (*OR* = 10.3275, $p < 0.001$), if the police caught the suspect at the scene (*OR* = 73.1840, $p < 0.001$), or if the victim and suspect knew each other (*OR* = 7.3661, $p < 0.001$) were also strong predictors of the odds of arrest

Combinations of Forensic Evidence across Crime Types

Table 3 shows how specific combinations of forensic evidence affect the odds of the police making an arrest across crime types. The Model Chi Square tests were all significant, indicating that the models fit the data well. As with the previous set of models shown in Table 2, the model for All Crimes is weighted by the number of cases within each crime type included in the model via the p-weight command in Stata. Consequently, the standard errors presented in the weighted regression model are robust standard errors.

When all the crime types are included in the weighted regression model, several of the forensic evidence combinations significantly increase the odds of arrest. For the mutually exclusive categories of forensic evidence, *Only Classification* (*OR* = 1.955, p = 0.015) and *Only Progenitor* (*OR* = 2.0504, p = 0.025) significantly increased the probability of arrest, with *Only Identification* having a negligible, positive effect. For the combinations of forensic evidence, the combination of *Classification* and *Progenitor* (*OR* = 2.3524, $p < 0.001$) had a strong consistent effect, with the combination of *Identification* and *Progenitor* having a strong but insignificant positive impact (*OR* = 1.8774, p = 0.078). Finally, collecting all three types of forensic evidence increased the odds of arrest by nearly 120% (*OR* = 2.1896, $p < 0.001$).

For homicide cases, very few cases collected only one type of forensic evidence. In fact, the gross majority of homicide cases (89%) collected at least two types of evidence. However, none of the combinations of forensic evidence nor when investigators collected only one type of forensic evidence[4] significantly predicted that the case would lead to an arrest. Factors such as whether the victim and suspect knew each other (*OR* = 3.2461, $p < 0.001$), if the suspect was non-White (*OR* = 2.7505, $p < 0.001$), and if the police apprehended the suspect within ten minutes (*OR* = 6.4218, $p < 0.001$) were all much stronger positive predictors of arrest. Conversely, the measure of whether the victim was a member of a racial minority had a negative, strong, but insignificant effect on arrest (*OR* = 0.5739, p = 0.098).

Most macro-types and combinations of forensic evidence were also not predictive of arrest in rape cases. This was similar to the results presented in Table 2. Only when investigators collected all three macro-types of forensic evidence did this lead to an increase in the odds of arrest (*OR* = 1.6594, p = 0.050), increasing the likelihood of an arrest by 66%. Again, the situational factors of being taken for treatment (*OR* = 2.6779, $p < 0.001$), a witness reporting the crime (*OR* = 2.6105, p = 0.007), the relationship between victim and suspect (*OR* = 5.0335, $p < 0.001$), and whether the police apprehended the suspect at the scene (*OR* = 28.7549, $p < 0.001$) were the strongest case predictors of arrest.

In assault cases, both the combinations of *Classification* and *Progenitor* (*OR* = 2.1855, p = 0.003) and *Classification* and *Identification* (*OR* = 14.7144, p = 0.002) forensic evidence and when investigators collected all three macro-types of evidence[5] were strong predictors of arrest (*OR* = 3.3071, p = 0.029). The combination of *Classification* and *Progenitor* increased the odds of arrest by nearly 120%. The result for the combination of *Classification* and *Identification* contrasts with the results presented in Table 2, where forensic evidence was not a strong predictor of arrests for assault, with *Identification* evidence having a strong but insignificant effect. An existing relationship between victim and suspect (*OR* = 1.8311, p = 0.003), the suspect being non-White (*OR* = 1.6633, p = 0.015), and the police apprehending the suspect quickly (*OR* = 20.9478, $p < 0.001$) were also strong, positive predictors of arrest. Being taken for treatment (*OR* = 0.5097, p = 0.005) or when the victim was non-white (*OR* = 0.4160, $p < 0.001$) or male (*OR* = 0.6391, p = 0.025), the police were also much less likely to make an arrest in that case. This is substantively consistent with the results presented in Table 2.

For robbery cases, collecting forensic evidence, especially combinations of forensic evidence, had a larger effect on the odds of arrest than collecting no forensic evidence. Cases that collected only *Classification* evidence were significantly more likely to result in an arrest compared to cases with no forensic evidence (*OR* = 2.6944, p = 0.029). Similarly, cases that collected a combination of *Classification* and *Progenitor* (*OR* = 3.2737, $p < 0.001$) or *Progenitor* and *Identification* (*OR* = 3.4510, p = 0.050) evidence had higher odds of arrest than cases where no evidence was collected, with the combination of *Classification* and *Identification* evidence having a strong but insignificant effect (*OR* = 5.1689, p = 0.082). Additionally, the victim and suspect's

Table 3: Effects of Combinations of Forensic Evidence Collection on Arrest

Variable	All Crimes			Homicide			Rape			Assault			Robbery			Burglary		
	b (se)	p	OR	b (se)	p	OR	b (se)	p	OR	b (se)	p	OR	b (se)	p	OR	b (se)	p	OR
Forensic Evidence																		
No Forensic Evidence (reference)																		
Only Classification	0.6706 (.2765)	0.015	1.9555	-0.0967 (.8250)	0.907	0.9078	0.9033 (.6702)	0.178	2.4676	0.2915 (.3876)	0.452	1.3384	0.9912 (.4553)	0..029	2.6944	-	-	-
Only Identification	0.2820 (.1941)	0.146	1.3258	-	-	-	0.4193 (.3314)	0.206	1.5209	0.1212 (1.0955)	0.912	1.1288	-0.1264 (.4672)	0.787	0.8813	0.2884 (.4693)	0.539	1.3342
Only Progenitor	0.7180 (.3210)	0.025	2.0504	-	-	-	-0.4257 (1.5164)	0.779	0.6533	0.6417 (.5361)	0.231	1.8997	0.5037 (.4583)	0.272	1.6548	3.53553 7 (.9305)	0.000	34.3108
Classification + Identification	0.3852 (.3488)	0.269	1.4699	0.1648 (.6998)	0.814	1.1792	-1.0630 (.8147)	0.192	0.3454	2.6888 (.8831)	0.002	14.7144	1.6427 (.9433)	0.082	5.1689	0.8940 (.7996)	0.264	2.4449
Classification + Progenitor	0.8554 (.1880)	0.000	2.3524	0.2307 (.6783)	0.734	1.2595	0.7690 (.4974)	0.122	2.1575	0.7818 (.2661)	0.003	2.1855	1.1859 (.2997)	0.000	3.2737	3.6071 (.7194)	0.000	36.8605
Identification + Progenitor	0.6299 (.3576)	0.078	1.8774	-0.1787 (.8768)	0.838	0.8364	0.4356 (1.2023)	0.717	1.5459	0.0253 (1.6988)	0.988	1.0256	1.2387 (.6321)	0.050	3.4510	-0.0322 (.8027)	0.968	0.9683
All Forensic Evidence Types	0.7837 (.1583)	0.000	2.1896	0.8555 (1.3919)	0.539	2.3526	0.5064 (.2579)	0.050	1.6594	1.1961 (.5478)	0.029	3.3071	0.7613 (.4884)	0.119	2.1411	0.7706 (.7021)	0.272	2.1611
Situational Controls																		
Taken for Treatment	0.2342 (.1356)	0.084	1.2638	0.1765 (.2509)	0.482	1.1931	0.9850 (.2506)	0.000	2.6779	-0.6739 (.2378)	0.005	0.5097	0.3688 (.3599)	0.305	1.4461	-	-	-
Witness Report	0.2684 (.1278)	0.036	1.3079	-0.1590 (.2509)	0.482	0.8530	0.9596 (.3588)	0.007	2.6105	0.1249 (.1878)	0.506	1.1331	-0.2048 (.2794)	0.464	0.8148	2.2758 (.4056)	0.000	9.7353
Suspect apprehend w/ 10 minutes	3.8732 (.2385)	0.000	48.0980	1.8597 (.4682)	0.000	6.4218	3.3588 (.6348)	0.000	28.7549	3.0420 (.2458)	0.000	20.9478	4.5591 (.4445)	0.000	95.5008	4.3763 (.6958)	0.000	79.5461
Victim – Suspect Relationship	1.2338 (.1314)	0.000	3.4342	1.1775 (.3096)	0.000	3.2461	1.6161 (.3045)	0.000	5.0335	0.6049 (.2028)	0.003	1.8311	0.9853 (.3085)	0.001	2.6786	2.1236 (.3170)	0.000	8.3610
Crime Type																		
Homicide	1.6283 (.2266)	0.000	5.0952															
Rape	1.0162 (.2085)	0.000	2.7626															
Assault	1.2536 (.1815)	0.000	3.5028															
Robbery	0.8141 (.1717)	0.000	2.2572															
Demographics																		
Non-White Victim	-0.2189 (.1175)	0.063	0.8034	-0.5554 (.3358)	0.098	0.5739	0.4111 (.2703)	0.128	1.5085	-0.8770 (.2180)	0.000	0.4160	-0.2458 (.2089)	0.239	0.7821	-0.2115 (.3218)	0.511	0.8094
Non-White Suspect	0.1892 (.1200)	0.115	1.2082	1.0118 (.2751)	0.000	2.7505	-0.0185 (.2643)	0.944	0.9817	0.5088 (.2087)	0.015	1.6633	-0.1965 (.2365)	0.406	0.8216	0.3891 (.4393)	0.376	1.4757
Male Victim	-0.1268 (.1259)	0.314	0.8809	0.2638 (.3525)	0.454	1.3018	- -	-	-	-0.4478 (.1994)	0.025	0.6391	-0.2433 (.1895)	0.199	0.7840	0.4684 (.2904)	0.107	1.5976
Male Suspect	-0.3446 (.2471)	0.163	0.7085	-0.1350 (.6599)	0.838	0.8737	- -	-	-	-0.2365 (.2623)	0.367	0.7894	-0.2381 (.3399)	0.484	0.7882	-0.6953 (.4775)	0.145	0.4989
Location																		
LA County	0.9584 (.1453)	0.000	2.6075	-0.5023 (.3384)	0.138	0.6052	1.5351 (.2675)	0.000	4.6416	2.0623 (.2690)	0.000	7.8637	1.1485 (.3682)	0.002	2.1533	0.6430 (.3470)	0.064	1.9022
Indianapolis	1.0151 (.1425)	0.000	2.7595	0.1304 (.4163)	0.754	1.1393	3.0764 (.3202)	0.000	21.6794	0.2994 (.2627)	0.254	1.3490	0.4086 (.3052)	0.181	1.5048	-0.9912 (.4441)	0.026	0.3711
Constant	-3.3735` (.2929)	0.000	0.0343	-0.4896 (.9770)	0.616	0.6128	-4.3866 (.4624)	0.000	0.0124	-1.0962 (.3669)	0.003	0.3341	-2.0105 (.4569)	0.000	0.1339	-3.4441 (.5742)	0.000	0.0319
N cases	4205			400			602			859			1081			1263		
Percent Correctly Classified	82.24%			72.00%			77.57%			78.70%			86.12%			94.92%		
Pseudo R^2	0.3098			0.1703			0.3097			0.3316			0.2824			0.4211		

relationship (*OR* = 2.6786, $p = 0.001$), as well as if the police apprehended the suspect quickly (*OR* = 95.5008, $p < 0.001$), were both strong predictors of arrest. These results were also broadly consistent with those presented in Table 2.

In burglary cases, there was very little variability across the seven categories of forensic evidence collection. This likely exaggerated the effects of these variables, as 80% of burglary cases did not collect any forensic evidence. The combination of *Classification* and *Progenitor* (*OR* = 36.8605, $p < 0.001$), as well as when investigators collected only *Progenitor* evidence (*OR* = 34.3108, $p < 0.001$), had very strong positive effects on whether the police made an arrest. While collecting *All Forensic Evidence Types* had a very strong effect, the large standard error indicates that this is not a consistent effect (*OR* = 2.1611, $p = 0.272$). When witnesses reported the crime (*OR* = 9.7353, $p < 0.001$), as well as when the suspect was apprehended quickly (*OR* = 79.5461, $p < 0.001$) were also strong predictors of arrest.

Submission of Evidence to the Laboratory

Table 4 displays the results of how the collection and analysis of forensic evidence affected the odds of arrest, net of other factors. The Model Chi Square, which was significant for all the regression models, indicates that the six models presented in Table 4 fit the data well. As with the models for all crimes presented in Table 2 and 3, a weighted logistic regression model is presented, which follows the same procedure. For the set of models presented in Table 4, the accuracy of the models' predictions is roughly the same as the two previous models.

When all cases are considered together in the weighted regression model, the collection of *Progenitor* evidence (*OR* = 1.5118, $p = 0.028$) consistently increased the odds of arrest, with the collection of *Classification* evidence having a strong but insignificant effect. However, the analysis of the forensic evidence macro-types did not have consistent effects when considered as an aggregate. As with the models displayed in Tables 2 and 3, several of the situational characteristics had very strong positive effects, with the demographic factors of the suspect and victim having negligible effects. Whether the victim was taken for treatment had a nearly significant positive effect on arrests, while whether a witness filed a report had a consistent effect (*OR* = 1.2854, $p = 0.049$). When disaggregated, however, the effects of collection and analysis of forensic evidence macro-types varied considerably.

In homicide cases, the collection of forensic evidence seemed to decrease the likelihood of making an arrest when it was not submitted for analysis. When it was, analysis of two of the three types of forensic evidence, *Identification* (*OR* = 2.2437, $p = 0.011$) and *Classification* (*OR* = 1.8987 $p = 0.044$), tended to have fairly strong positive effects on the odds of arrest. However, the effects of the collection of the three macro-types of forensic evidence, net of their being analyzed and other factors, was non-significant. The situational and demographic factors were broadly similar to the previous analysis of homicides, with the case involving a non-White suspect (*OR* = 2.7029, $p < 0.001$), the suspect being apprehended quickly (*OR* = 7.2396, $p < 0.001$), and the victim and suspect having a relationship (*OR* = 3.4483, $p < 0.001$) all strongly associated with improved odds of arrest.

The collection and analysis of the three macro-types of evidence also did not have a consistent effect in rape cases. While the effects of the collection of the three macro-types of evidence were broadly similar to the earlier analyses, by including the analysis of evidence in the model, the variables representing the collection of the three evidence macro-types had stronger, but still not significant, effects on the odds of arrest. Indeed, as with the model presented in Table 2 and 3, whether the victim sought treatment after the sexual assault (*OR* = 2.6380, $p < 0.001$), if a witness filed a report (*OR* = 2.5028, $p < 0.001$), if the victim and suspect knew each other (*OR* = 5.0480, $p < 0.001$), or if the police apprehended the suspect at the scene (*OR* = 29.8782, $p < 0.001$) had much more consistent effects on the likelihood of an arrest in rape cases.

Similarly, the collection and analysis of the three macro-types of forensic evidence had no consistent direct effect on the odds of making an arrest for assaults. Collecting *Identification* evidence was associated with a strong but inconsistent increase in the odds of arrest (*OR* = 2.3423, $p = 0.056$, which broadly similar to its effect seen in Table 2. As with the models presented in Tables 2 and 3, the police apprehending the suspect quickly (*OR* = 20.5354, $p < 0.001$) and the victim and suspect having a relationship (*OR* = 1.8498, $p = 0.002$) increased the odds of arrest, while the victim seeking treatment decreased them (*OR* = 0.5019, $p = 0.004$). The demographic factors also had similar effects across the three models.

In robbery cases, while the collection of *Classification* evidence (*OR* = 1.9891, $p = 0.044$) increased the odds of arrest by nearly 99%, the analysis of any macro-type of evidence did not have a consistent effect. The situational factors of the police apprehending the suspect quickly (*OR* = 98.1957, $p < 0.001$) and the victim and suspect having a relationship (*OR* = 2.7660, $p = 0.001$) had similar effects across the three sets of models.

Finally, the analysis of forensic evidence had little effect on the odds of arrest in burglary cases, with

Table 4: Effects of Collection and Analysis of Forensic Evidence Collection on Arrest

Variable	All Crimes			Homicide			Rape		
	b (se)	p	OR	b (se)	p	OR	b (se)	p	OR
Forensic Evidence									
Collection									
Classification	0.3547 (.1960)	0.070	1.4258	-0.6719 (.7286)	0.356	0.5107	0.2313 (.4712)	0.624	1.2602
Identification	-0.0176 (.1532)	0.909	0.9826	-0.5545 (.3638)	0.127	0.5744	0.0229 (.3086)	0.941	1.023
Progenitor	0.4133 (.1883)	0.028	1.5118	-0.0891 (.4396)	0.839	0.9148	0.0871 (.5131)	0.865	1.0910
Analysis									
Classification	-0.0381 (.2514)	0.880	0.9626	0.4035 (.4615)	0.382	1.4970	-0.9013 (.6402)	0.159	0.4065
Identification	0.1619 (.1589)	0.308	1.1757	0.8081 (.3178)	0.011	2.2437	.2322 (.3005)	0.440	1.2614
Progenitor	-0.0596 (.2234)	0.790	0.9421	0.6412 (.3184)	0.044	1.8987	0.8412 (.7054)	0.233	2.3192
Situational Controls									
Taken for Treatment	0.2483 (.1369)	0.070	1.2818	0.2727 (.2580)	0.291	1.3135	0.9700 (.2597)	0.000	2.6380
Witness Report	0.2510 (.1278)	0.049	1.2854	-0.1658 (.2730)	0.544	0.8472	0.9174 (.3556)	0.010	2.5028
Suspect apprehend w/ 10 minutes	3.8862 (.2376)	0.000	48.7266	1.9796 (.4849)	0.000	7.2396	3.3971 (.6350)	0.000	29.8782
Victim – Suspect Relationship	1.2378 (.1310)	0.000	3.4479	1.2379 (.3181)	0.000	3.4483	1.6190 (.3022)	0.000	5.0480
Crime Type									
Homicide	1.6452 (.2645)	0.000	5.1819						
Rape	1.0250 (.2058)	0.000	2.7871						
Assault	1.2773 (.1818)	0.000	3.5871						
Robbery	0.8402 (.1705)	0.000	2.3167						
Demographics									
Non-White Victim	-0.2229 (.1175)	0.058	0.8002	-0.4684 (.3412)	0.170	0.6260	0.3877 (.2694)	0.150	1.4736
Non-White Suspect	0.1937 (.1205)	0.108	1.2138	0.9943 (.2796)	0.000	2.7029	-0.0181 (.2646)	0.946	0.9821
Male Victim	-0.1218 (.1254)	0.331	0.8853	0.2597 (.3461)	0.453	1.2966			
Male Suspect	-0.3271 (.2465)	0.184	0.7210	-0.2575 (.6620)	0.697	0.7730			
Location									
LA County	0.9632 (.1530)	0.000	2.6201	-1.0172 (.3807)	0.008	0.3616	1.4511 (.3287)	0.000	4.2680
Indianapolis	1.0367 (.1427)	0.000	2.8199	0.3094 (.4199)	0.461	1.3626	3.0316 (.3173)	0.000	20.7298
Constant	-3.3807 (.2942)	0.000	0.0340	-0.1563 (.9877)	0.874	0.8553	-4.2317 (.4525)	0.000	0.0145
N cases	4205			400			602		
Percent Correctly Classified	82.16%			70.00%			76.91%		
Pseudo R^2	0.3091			0.1949			0.3049		

Variable	Assault			Robbery			Burglary		
	b (se)	p	OR	b (se)	p	OR	b (se)	p	OR
Forensic Evidence									
Collection									
Classification	0.3974 (.3510)	0.258	1.4880	0.6877 (.3413)	0.044	1.9891	0.8261 (.5569)	0.138	2.2844
Identification	0.8511 (.4459)	0.056	2.3423	-0.0297 (.3394)	0.930	0.9707	-0.7925 (.5446)	0.146	0.4527
Progenitor	0.3044 (.3558)	0.392	1.3558	0.4489 (.3394)	0.186	1.5665	1.5744 (.4975)	0.002	4.8280
Analysis									
Classification	0.1751 (.4452)	0.694	1.1914	0.2211 (.4591)	0.630	1.2474	-	-	
Identification	-0.2581 (.5514)	0.640	0.7725	-0.0410 (.3395)	0.904	0.9598	-0.0656 (.5722)	0.909	0.9366
Progenitor	0.0941 (.5351)	0.860	1.0987	-0.0449 (.5078)	0.930	0.9561	0.8331 (1.1884)	0.483	2.3004
Situational Controls									
Taken for Treatment	-0.6894 (.2373)	0.004	0.5019	0.3621 (.3584)	0.312	1.4363	-	-	-
Witness Report	0.1032 (.1870)	0.581	1.1087	-0.2035 (.2796)	0.467	0.8158	2.3059 (.3988)	0.000	10.0327
Suspect apprehend w/ 10 minutes	3.0222 (.2464)	0.000	20.5354	4.5870 (.4435)	0.000	98.1957	4.2972 (.7036)	0.000	73.4911
Victim – Suspect Relationship	0.6151 (.2017)	0.002	1.8498	1.0174 (.3061)	0.001	2.7660	2.0127 (.3081)	0.000	7.4833
Crime Type									
Homicide									
Rape									
Assault									
Robbery									
Demographics									
Non-White Victim	-0.8849 (.2150)	0.000	0.4128	-0.2354 (.2094)	0.261	0.7903	-0.2527 (.3197)	0.429	0.7767
Non-White Suspect	0.5077 (.2065)	0.014	1.6614	-0.1849 (.2360)	0.433	0.8312	0.6408 (.4179)	0.125	1.8980
Male Victim	-0.4078 (.1980)	0.039	0.6651	-0.2543 (.1882)	0.177	0.7755	0.4284 (.2848)	0.133	1.5347
Male Suspect	-0.2261 (.2613)	0.387	0.7976	-0.2136 (.3381)	0.528	0.8077	-0.5691 (.4727)	0.229	0.5661
Location									
LA County	2.0513 (.2653)	0.000	7.7781	1.1541 (.3660)	0.002	3.1711	0.5417 (.3382)	0.109	1.7189
Indianapolis	0.2782 (.2608)	0.286	1.3207	0.4610 (.3000)	0.124	1.5857	-1.0576 (.4315)	0.014	0.3473
Constant	-1.1047 (.3658)	0.003	0.3313	-2.0449 (.4568)	0.000	0.1294	-3.3530 (.5666)	0.000	0.0350
N cases	859			1081			1263		
Percent Correctly Classified	78.93%			85.94%			94.12%		
Pseudo R^2	0.3278			0.2794			0.3984		

neither the analysis of *Identification* nor *Progenitor* evidence having a consistent effect. However, the collection of *Progenitor* evidence (*OR* = 4.8280, *p* = 0.002) had a similar effect in this model as it did in the first with regards to its direction, magnitude, and consistency. The effects of the situational factors of whether a witness made a report (*OR* = 10.0327, p < 0.001), the police apprehending the suspect quickly (*OR* = 73.4911, *p* < 0.001), or if the victim and suspect knew each other (*OR* = 7.4833, *p* < 0.001) all had very similar effects on the odds of arrest, as did the demographic factors.

On average, the use of macro-types of forensic evidence, in conjunction with the situational and demographic characteristics, improved model accuracy by roughly 17% compared to the null model. The largest improvement was in assault cases, with a 27.98% improvement. However, the model only improved prediction of burglary arrests by 2.65%. This is likely due to the rarity of arrests for burglaries.

Discussion

The analyses described above provide some information about the ability of the three macro-types of forensic evidence to affect the odds of arrest across various crime types. First, no forensic evidence macro-type or combination of evidence was a consistently strong predictor of arrest across crime types. The situational factors of the police apprehending the suspect at the scene and whether the victim knew the suspect were the most consistent, positive predictors of arrest across all five crime types. The inconsistent relationship between the collection of forensic evidence and the odds of arrest for the three more severe crime types, in particular, may be due to the nature of the crimes, themselves. Total strangers rarely commit homicides, rapes, and assaults. Rather, friends, family members, and acquaintances are the most common perpetrators of these crimes. Therefore, investigators may discover more from an interview with the victim or witnesses than forensic evidence when trying to identify a suspect and establish probable cause for arrest. Taken together, this means that studying the effect of forensic evidence on the likelihood of arrest for all crime types omits these findings. Instead, exploring how forensic evidence affects outcomes across different crimes is more fruitful, as shown above.

Second, the macro-types of forensic evidence often had opposing or complementary effects. This supports the use of this typology as it is important to understand in what contexts the different types of forensic evidence are useful. In homicide cases, the police's collection of forensic evidence had no consistent effect on the odds of arrest. Rather, when the police apprehended the suspect at the scene and whether the victim knew their attacker were the only consistent and positive predictors of arrest across the three models. This may suggest that the situational factors play a more important role in obtaining a warrant for arrest than forensic evidence, with even the *All Types of Forensic Evidence Collected* (64% of all homicide cases) showing no effect. This is broadly similar to Baskin and Sommer's (2010) findings on the odds of arrest and McEwen and Regoeczi's (2015) results on case clearances. It may also suggest that since homicide cases often involve so much forensic evidence, that the effect of collecting or analyzing the macro-types may be diminished to insignificance. Additionally, the finding that the submission of *Identification* or *Progenitor* evidence for analysis increases the odds of arrest in homicide cases may be due to investigators being more likely to submit collected evidence to the lab, regardless of whether they need the analysis report to identify an unknown suspect to support later decisions by prosecutors. The models' average accuracy of 71.00% may suggest that there may be an unmeasured factor at work, such as the usefulness of the evidence to the case or the amount of time spent investigating.

Forensic evidence was also not useful in arresting rape suspects when measured across macro-types unless investigators collected all three. However, the analysis of forensic evidence did not have an effect. In contrast, the prior literature, particularly Johnson and colleagues (2012) and Campbell and colleagues (2009) suggested that any forensic evidence could significantly increase the odds of successful case outcomes. This incongruity could be caused by several factors. For instance, Johnson and colleagues' finding that crime scene evidence increased the odds of arrest by 150% could be due to their aggregating all forensic evidence categories into one variable or not including whether the victim sought treatment in their model. Similarly, Campbell and colleagues' finding that forensic evidence collected by medical personnel increased the odds of arrest may be more related to the victim seeking medical and police assistance soon after the assault, thereby providing more reliable forensic evidence and testimony to assist in the investigation.

Forensic evidence's effect in assault and robbery cases was also inconsistent with the prior literature. The collection of *Classification* evidence significantly increased the odds of arrest in robberies both by itself and when accounting for whether it was submitted to the lab, while the combinations of *Classification* and *Progenitor* evidence types had a much stronger, positive effect on the odds of arrest. The combination of *Progenitor* and *Identification* evidence had an even stronger, though less consistent effect. However, when investigators collected all three types of forensic evidence, the odds of arrest decreased dramatically. This suggests that forensic evidence plays an important role both to associate perpetrators to the scene and to reconstruct the events. In the first and third models, the forensic evidence types did not have an effect in assault cases. However, when combinations of forensic evidence macro-types were included in the regression model, the combinations of *Classification* and *Progenitor*, as well as *Classification* and *Identification* evidence, strongly predicted arrest. As with robberies, this suggests that investigators are more reliant on multiple types of forensic evidence to make an arrest.

Similar to robberies and assaults, forensic evidence's effect on the odds of arrest in burglaries was somewhat inconsistent with the literature. The collection and analysis of *Identification* evidence actually decreased the odds of arrest in the first and third analyses, which contradicts Bond's (2007) findings that the analysis of DNA evidence increased the odds of arrest. This may be due to Bond focusing on DNA evidence only, rather than DNA and fingerprints, as well as his focus on the analysis of evidence, rather than collection. More consistent with the literature was the finding that *Progenitor* evidence increased the odds of arrest on its own and in combination with *Classification* evidence, similar to Baskin and Sommers (2011). These findings may support the notion that the police only collect and process *Identification* evidence when they do not have a suspect in mind (Schroeder & White, 2009). Thus, *Identification* evidence could be used as an indicator of a lack of available investigative leads in the future.

The findings across the three sets of regression models illustrate several important points. First, they demonstrate how the standard method of determining forensic evidence's effect on criminal justice outcomes misses unique variation across crime in both crime types and macro-types of evidence. Analyses of the same data using a single, dichotomous variable to represent forensic evidence collection, found much different results (Baskin & Sommers, 2012; Johnson et al., 2012). Both articles found much stronger effects for the collection of any forensic evidence, with those effects diminishing once forensic evidence was categorized into macro-types. Thus, from a practitioner-focused standpoint, researchers could operationalize their measurement of forensic evidence into the three macro-types identified above (*Classification*, *Identification*, and *Progenitor*) to determine how each affect case outcomes differently. This change would allow departments to take advantage of this research and change investigator trainings to account for which evidence macro-type is effective across contexts. Based on the results of this study, departments could emphasize the need for *Classification* and *Progenitor* evidence to aid in arrests for burglaries and robberies, while emphasizing the need for victims to seek medical treatment for rape. Since *Identification* evidence was not helpful to obtaining an arrest in most situations, departments may wish to focus their resources on gathering *Classification* and *Progenitor* evidence instead. This would also be consistent with Schroeder and White's (2009) finding that investigators use *Identification* evidence only when they are out of other leads in the case.

The findings also suggest that some of the practical constraints or the factors that may influence investigators' perceived likelihood of a successful arrest and prosecution, namely the three macro-types of forensic evidence, do not have consistent effects across crime types. While this may be due to investigators needing to satisfy different statutory definitions to arrest suspects in different cases, it may also suggest that these practical constraints interact with the other elements. In effect, the investigator's perceptions of the practical constraints of the case depend on the crime type. This explains why the macro-types of forensic evidence are unrelated to arrests in rape and homicide cases, because since both are likely to involve forensic evidence, the investigation may depend on the victim seeking prompt medical treatment to preserve the forensic evidence in rape cases or a pre-existing relationship between the victim and suspect in homicide cases to provide crucial context to support making an arrest. In contrast, investigations of more impersonal crimes like robbery and burglary may depend on being able to identify a suspect and reconstruct the crime event. This difference in the macro-types' effects across crime types suggests that investigators use forensic evidence differently depending on the crime type.

It is also important to note that the analysis of any type of forensic evidence did not significantly affect the odds of arrest across burglary, robbery, and assault, which supports the idea that investigators do not rely on laboratory reports to make arrests except in cases where they lack any other investigative leads (King et al., 2017; Schroeder & White, 2009). In cases of sexual assault, the analysis of the evidence *Identification* and *Progenitor* evidence had strong and consistent positive effects, supporting Campbell and colleagues' (2017) findings concerning the submission of sexual assault kits. In homicide cases, investigators may submit evidence for analysis in cases that look promising in the hopes of supporting future prosecution as Schroeder and White (2009) argue, rather than using the analysis to produce investigative leads. These findings across crime types suggest that the three categories of forensic evidence, as well as their combinations, can be a useful way to evaluate forensic evidence. Thus, when forensic evidence is measured more precisely, it supports the some of the prior literature's findings (Baskin & Sommers, 2012; Peterson et al., 1984) and provides more specificity in how forensic evidence's relationship with decision-making works.

These analyses also show that the field should avoid combining crime types when studying criminal justice decision-making. When the five crime types were included in the regression model, both the collection of *Classification* and *Progenitor* evidence were strongly related to the decision to arrest, as shown in Tables 2-4. However, once the data were disaggregated and reanalyzed for each crime type, forensic evidence became a much less reliable predictor across the models. While the initial results of this analysis were consistent with Peterson and colleagues (2013) for all crime types, it is very likely that the relationship between forensic evidence and arrest in burglaries, and to a lesser extent in robberies and assaults, is driving that correlation. Combining crime types also obscures the relationship between *Identification* evidence and arrest in burglaries.

Limitations

While this research contributes to the field's understanding of how different macro-types of forensic evidence influence the decision to arrest across crime types, there are several key limitations inherent in this study. First, it should be noted that the results reported above are unable to indicate whether forensic evidence causes arrests as the dataset lacks information about when in the process the police collected the evidence (i.e., before or after arrest). It also does not include how long investigators spent on each individual case before closing it with an arrest or calling it unsolved. Relatedly, the data provides no information about where (e.g., at the scene, hospital, suspect's residence, etc.) and in what stage of the investigation the evidence was collected and/or analyzed (e.g., initial, after suspect was identified, etc.). Future research will want to give careful attention to these points because such information could help explore whether detectives' tenacity, the timing of forensic evidence collected and analyzed, and the availability of resources affected some of the relationships highlighted in this study.

Second, the data used in this study is nearly two decades old, which may suggest that the current relationship between forensic evidence and the decision to arrest has changed. However, because forensic evidence has received more attention since 2006, when the most recent case included in this study occurred, it is likely that the effects of the three macro-types of forensic evidence is more pronounced now. Additionally, the age of the dataset provides a useful comparison for future research to examine how decision-making has changed since 2006.

Finally, this study relies on evidence collected in two U.S. States, across five sites. While this is a criticism of limited generalizability that can be leveled against most studies of the predictors of criminal justice actors' decisions, the use of five, rather than one jurisdiction (Campbell et al., 2017; McEwen & Regoeczi, 2015; Schroeder & White, 2009), somewhat addresses this. As with the second key limitation, this study provides a useful comparison for other research to examine how the influence of forensic evidence is similar or different in other jurisdictions.

Future Directions

Several expansions on this article's findings are possible. A qualitative approach, such as the one employed by King and colleagues (2017) or Campbell and colleagues (2017), could explore the individual effects of evidence on criminal justice outcomes by determining if forensic evidence macro-types affected criminal justice actors' decisions in the process, especially in how different macro-types of evidence affect criminal justice actors across the entire process. A more extensive analysis of criminal cases could also facilitate comparisons of how the different macro-types of forensic evidence affected decision-making, with all other factors being equal. Researchers could also explore issues of causality by gathering more information from the case files about when, where, and how useful forensic evidence was in the decision-making process. Given that forensic evidence has and will continue to play a critical role in criminal justice decision-making, researchers and practitioners should continue to work together to understand that relationship. In analyzing forensic evidence as distinct types, rather than a single construct, research can continue to understand how criminal justice actors make decisions and improve how investigators collect and use forensic evidence.

References

Al Awadhi, I., Read, J., Marrington, A., & Franqueira, V. (2015). Factors influencing digital forensic investigations: Empirical evaluation of 12 years of Dubai police cases. *Journal of Digital Forensics, Security and Law*, *10*(4), 7–16. https://doi.org/10.15394/jdfsl.2015.1207

Baskin, D. R., & Sommers, I. B. (2010a). Crime-show viewing habits and public attitudes toward forensic evidence: The "CSI Effect" revisited. *The Justice System Journal*, *31*(1), 97–113. https://10.1080/0098261X.2010.10767956

Baskin, D. R., & Sommers, I. B. (2010b). The influence of forensic evidence on the case outcomes of homicide incidents. *Journal of Criminal Justice*, *38*(6), 1141–1149. https://doi.org/10.1016/j.jcrimjus.2010.09.002

Baskin, D. R., & Sommers, I. B. (2011). Solving residential burglaries in the United States: The impact of forensic evidence on case outcomes. *International Journal of Police Science & Management*, *13*(1), 70–86. https://doi.org/10.1350/ijps.2011.13.1.224

Baskin, D. R., & Sommers, I. B. (2012). The influence of forensic evidence on the case outcomes of assault and robbery incidents. *Criminal Justice Policy Review*, *23*(2), 186–210. https://doi.org/10.1177/0887403410395576

Bond, J. W. (2007). Value of DNA evidence in detecting crime. *Journal of Forensic Sciences*, *52*(1), 128–136. https://doi.org/10.1111/j.1556-4029.2006.00323.x

Campbell, R., Fehler-Cabral, G., Bybee, D., & Shaw, J. (2017). Forgotten evidence: A mixed methods study of why sexual assault kits (SAKs) are not submitted for DNA forensic testing. *Law and Human Behavior*, 1–14. http://dx.doi.org/10.1037/lhb0000252

Campbell, R., Patterson, D., Bybee, D., & Dworkin, E. R. (2009). Predicting sexual assault prosecution outcomes. *Criminal Justice and Behavior*, *36*(7), 712–727. https://doi.org/10.1177/0093854809335054

Figueira-McDonough, J. (1985). Gender differences in informal processing: A look at charge bargaining and sentence reduction in Washington D.C. *Journal of Research in Crime and Delinquency*, *22*(2), 101–133. https://doi.org/0803973233

Giannelli, P. C. (2006). Forensic science. *The Journal of Law, Medicine & Ethics*, *34*(2), 310–319. https://doi.org/10.1111/j.1748-720X.2006.00036.x

Gottfredson, M. R., & Gottfredson, D. M. (1988). *Decision making in criminal justice: Toward the rational exercise of discretion* (2nd ed.). Plenum Press.

Guerrini, C. J., Robinson, J. O., Petersen, D., & McGuire, A. L. (2018). Should police have access to genetic genealogy databases? Capturing the Golden State Killer and other criminals using a controversial new forensic technique. *PLoS Biology*, *16*(10), 1–9. https://doi.org/10.1371/journal.pbio.2006906

Horvath, F., & Meesig, R. (1998). A content analysis of textbooks on criminal investigation: an evaluative comparison to empirical research findings on the investigative process and the role of forensic evidence. *Journal of Forensic Sciences*, *43*(1), 133–140. https://doi.org/10.1520/JFS16217J

Johnson, D. J., Peterson, J. L., Sommers, I. B., & Baskin, D. R. (2012). Use of forensic science in investigating crimes of sexual violence: Contrasting its theoretical potential with empirical realities. *Violence Against Women*, *18*(2), 193–222. https://doi.org/10.1177/1077801212440157

Kafadar, K. (2015). Statistical issues in assessing forensic evidence. *International Statistical Review*, *83*(1), 111–134. https://doi.org/10.1111/insr.12069

Kiely, T. F. (2001). *Forensic evidence: Science and the criminal law*. CRC Press.

King, W. R., Campbell, B. A., Matusiak, M. C., & Katz, C. M. (2017). Forensic evidence and criminal investigations: The impact of ballistics information on the investigation of violent crime in nine cities. *Journal of Forensic Sciences*, *62*(4), 874–880. https://doi.org/10.1111/1556-4029.13380

Kruse, C. (2012). Legal storytelling in pre-trial investigations: Arguing for a wider perspective on forensic evidence. *New Genetics and Society*, *31*(3), 299–309. https://doi.org/10.1080/14636778.2012.687084

Locard, E. (1930). The analysis of dust traces, Part I. *The American Journal of Police Science*, *1*(3), 276–298.

McEwen, T., & Regoeczi, W. (2015). Forensic evidence in homicide investigations and prosecutions. *Journal of Forensic Sciences*, *60*(5), 1188–1198. https://doi.org/10.1111/1556-4029.12787

National Research Council. (2009). *Strengthening forensic science in the United States: A path forward*. The National Academies Press. https://doi.org/10.1016/0379-0738(86)90074-5

Novak, K. J., Frank, J., Smith, B. W., & Engel, R. S. (2002). Revisiting the decision to arrest: Comparing beat and community officers. *Crime & Delinquency*, *48*(1), 70–98. https://doi.org/10.1177/0011128702048001003

Parsons, T. J., Huel, R. M. L., Bajunović, Z., & Rizvić, A. (2019). Large scale DNA identification: The ICMP experience. *Forensic Science International: Genetics*, *38*(1), 236–244. https://doi.org/10.1016/j.fsigen.2018.11.008

Peterson, J. L., Hickman, M. J., Strom, K. J., & Johnson, D. J. (2013). Effect of forensic evidence on criminal justice case processing. *Journal of Forensic Sciences*, *58*(S1), 78–90. https://doi.org/10.1111/1556-4029.12020

Peterson, J. L., Mihajlovic, S., & Gilliland, M. (1984). *Forensic evidence and the police : The effects of scientific evidence on criminal investigations*. U.S. Department of Justice, National Institute of Justice. https://www.ncjrs.gov/pdffiles1/95704.pdf

Peterson, J., & Sommers, I. (2010). *Impact of Forensic Evidence on the Criminal Justice Process in Five Sites in the United States, 2003-2006*. Inter-university Consortium for Political and Social Research. https://doi.org/10.3886/ICPSR29203.v1

Roman, J. K., Reid, S. E., Chalfin, A. J., & Knight, C. R. (2009). The DNA field experiment: A randomized trial of the cost-effectiveness of using DNA to solve property crimes. *Journal of Experimental Criminology*, *5*, 345–369. https://doi.org/10.1007/s11292-009-9086-4

Schroeder, D. A., & White, M. D. (2009). Exploring the use of DNA evidence in homicide investigations: Implications for detective work and case clearance. *Police Quarterly*, *12*(3), 319–342. https://doi.org/10.1177/1098611109339894

Steffensmeier, D. J., Ulmer, J., & Kramer, J. (1998). The interaction of race, gender, and age in criminal sentencing: The punishment cost of being young, black, and male. *Criminology*, *36*(4), 763–798. https://doi.org/10.1111/j.1745-9125.1998.tb01265.x

Sun, I. Y., & Payne, B. K. (2004). Racial differences in resolving conflicts: A comparison between Black and White police officers. *Crime & Delinquency*, *50*(4), 516–541. https://doi.org/10.1177/0011128703259298

Wilson, D. B., McClure, D., & Weisburd, D. L. (2010). Does forensic DNA help to solve crime? The benefit of sophisticated answers to naive questions. *Journal of Contemporary Criminal Justice*, *26*(4), 458–469. https://doi.org/10.1177/1043986210377231

Wilson-Wilde, L. (2018). The international development of forensic science standards — A review. *Forensic Science International*, *288*, 1–9. https://doi.org/10.1016/j.forsciint.2018.04.009

About the Author

Morgan Steele is an Assistant Professor within the Department of Criminal Justice at Fort Hays State University. He earned his Ph.D. in Criminal Justice at the University of Cincinnati, with a focus on policing and community criminology. His research interests are the use of forensic evidence in the criminal justice system, police effectiveness, structural predictors of violence, and quantitative methodology.

Endnotes

[1] Homicides were excluded from the first set of analyses because the cases typically included multiple types of evidence as 60% of homicides had *Identifier* evidence, 86% *Progenitor*, and 97% *Classification*, leading to there being little unique variability that could be used to compare one type of evidence against another
[2] Race/Ethnicity was coded "0" = Caucasian, "1" = Non-White (Black or Hispanic)
[3] The amalgam of the three Indiana cities was used as the reference category for the regression analysis and all comparisons are against them.
[4] Both *All Forensic Evidence Types* and *Classification/Progenitor* displayed high levels of multicollinearity (VIF = 17.4, 19.3, respectively) for homicide cases, meaning the results from this model—especially with respect to these variables—should be interpreted cautiously.
[5] *All Forensic Evidence Types* was shown to have significant issues with multicollinearity with the decision to arrest in assault cases (VIF = 33.42).

Appendix 1: Individual Evidence Collection Variables Assigned to Three Evidence Categories

Classification (% of all Cases w/ this type)	*Identification* (% Yes)	*Progenitor* (% Yes)
Firearms evidence collected (14.2)	Latent Prints collected (10.9)	Total Objects Collected (7.5)
Trace collected (0.7)	Bite Marks collected (0.0)	Drugs collected (2.0)
Total Trace evidence collected (5.2)	Blood collected (5.2)	Furniture collected (0.3)
Impression/Pattern evidence collected (3.3)	Palm Prints collected (0.5)	Footwear collected (1.7)
Natural/Synthetic materials collected (14.9)	Saliva collected (0.5)	Tools collected (0.4)
Other evidence collected (1.8)	DNA collected (1.2)	Bed & Bath Materials collected (2.1)
Explosives collected (0.0)	Tissue Samples collected (0.0)	Other Biological Evidence collected (0.9)
Fire Debris collected (0.3)	Semen collected (1.0)	Computers collected (0.1)
Door Samples collected (0.8)	Footprints collected (0.5)	Appliance collected (0.1)
Floor Samples collected (0.6)	Sexual assault kit collected from victim (7.7)	Cigarette Butts collected (0.3)
Blood Patterns collected (0.9)	Feces collected (0.0)	Electronics collected (0.7)
Glass Fragments collected (0.7)	Fingerprints collected (10.6)	Clothing collected (13.3)
Pavement Samples collected (0.3)	Bone Samples collected (0.0)	Sink collected (0.0)
Plastic Fragments collected (1.0)	Biological evidence collected (12.7)	Containers collected (2.5)
Vehicle Collision evidence collected (0.2)		Guns collected (4.6)
Window Samples collected (1.0)		Non-gun weapons collected (3.6)
Hair collected (1.5)		Documents collected (1.7)
Gun Shot Residue collected (1.0)		Vehicles collected (2.5)
Tire Prints collected (0.1)		Condom collected (0.3)
Fibers collected (0.1)		Fabric collected (0.0)
Wood Fragments collected (0.0)		Paper collected (1.0)
Shoe Prints collected (0.3)		Bindings collected (0.7)
Fire Igniter collected (0.2)		Cartridges collected (3.4)
Pubic Hair collected (0.1)		Bullet Casings collected (7.1)
Paint Samples collected (0.1)		Bullets collected (7.6)
Wall Samples collected (0.1)		
Fire Accelerants Collected (0.0)		
Scents collected (0.0)		
Rubber Samples collected (0.0)		
Bullets collected (7.6)		
Bullet Casings collected (7.1)		

Note: If case percentage = 0.0 then number collected ≥ 5.

Appendix 2: Individual Evidence Analysis Variables Assigned to Three Evidence Categories

Classification (% of all Cases with this type)	*Identification* (% Yes)	*Progenitor* (% Yes)
Ballistic Evidence (9.5%)	Biological Evidence (6.6%)	Bed & Bath Materials (0.7%)
Bullets (6.4%)	Bite Marks (0.0%)	Bindings (0.2%)
Carpet (0.1%)	Blood (3.2%)	Cartridges (2.3%)
Door Samples (0.0%)	Blood Stains (0.0%)	Cigarette Butts (0.4%)
Fibers (0.0%)	DNA (0.8%)	Clothing (4.5%)
Fire Accelerants (0.0%)	Feces (0.1%)	Computer (0.0%)
Fire Debris (0.0%)	Footprint (0.0%)	Condom (0.1%)
Fire Igniter (0.1%)	Latent Prints (11.2%)	Container (1.4%)
Glass Fragments (0.3%)	Other Biological Evidence (0.4%)	Drugs (1.6%)
Gunshot Residue (0.8%)	Palm Prints (0.4%)	Electronic Data (0.5)
Hair (0.6%)	Saliva (1.6%)	Electronics (0.2%)
Impression/Pattern (1.1)	Semen (1.4%)	Footwear (0.8%)
Metal Fragments (0.4%)	Sexual Assault Kit (2.5%)	Gun (3.5%)
Natural/Synthetic Materials (5.1%)	Tissue (0.1%)	Non-Gun Weapons (0.7%)
Other Evidence	Urine (0.4%)	Objects (1.5%)
Paint Sample (0.1%)	Vaginal Sample (0.5%)	Paper (0.5%)
Plastic Fragments (0.5%)		Vehicle (0.0%)
Pubic Hair (0.2%)		
Rubber (0.1%)		
Scent (0.6%)		
Shoe Prints (0.2%)		
Tire Prints (0.1%)		
Total Trace (2.4%)		
Trace (0.2%)		

Note: If case percentage = 0.0 then number collected ≥ 5. Some categories have very similar names (e.g., Total Trace and Trace). These are assumed to be categories from one of the three study sites. Dichotomizing the variables into the macro-categories addressed any potential duplication.

Appendix 3: Weighted vs. Un-Weighted Regression Models for All Crimes

	Collection				Combinations				Collection & Analysis			
Variable	**Weighted**		**Un-Weighted**		**Weighted**		**Un-Weighted**		**Weighted**		**Un-Weighted**	
	b se	p	b se	p	b se	p	b se	p	b se	p	b se	p
Forensic Evidence												
Collection												
Classification	.3934 (.2048)	0.055	.3369 (.1671)	0.044					0.3547 (.1960)	0.070	0.3110 (.1670)	0.063
Identification	-.0352 (.1667)	0.833	.0423 (.1486)	0.776					-0.0176 (.1532)	0.909	0.1163 (.1459)	0.425
Progenitor	.4654 (.2047)	0.023	.5005 (.1684)	0.003					0.4133 (.1883)	0.028	0.4585 (.1620)	0.005
Combinations												
Only Classification					0.6706 (.2765)	0.015	0.5771 (.2281)	0.011				
Only Identification					0.2820 (.1941)	0.146	0.3273 (.1909)	0.086				
Only Progenitor					0.7180 (.3210)	0.025	1.0510 (.2772)	0.000				
Classification + Progenitor					0.3852 (.3488)	0.269	0.5750 (.3018)	0.057				
Classification + Identification					0.8554 (.1880)	0.000	0.7413 (.1568)	0.000				
Identification + Progenitor					0.6299 (.3576)	0.078	0.5133 (.3480)	0.140				
All Forensic Evidence					0.7837 (.1583)	0.000	0.8288 (.1491)	0.000				
Analysis												
Classification									-0.0381 (.2514)	0.880	-0.0776 (.2099)	0.712
Identification									0.1619 (.1589)	0.308	0.0467 (.1471)	0.751
Progenitor									-0.0596 (.2234)	0.790	-0.0765 (.1955)	0.696
Situational Controls												
Taken for Treatment	.3700 (.1667)	0.026	.0305 (.1407)	0.828	0.2342 (.1356)	0.084	-0.0131 (.1180)	0.912	0.2483 (.1369)	0.070	-0.0178 (.1188)	0.881
Witness Report	.2693 (.1505)	0.074	.2324 (.1197)	0.052	0.2684 (.1278)	0.036	0.2224 (.1069)	0.038	0.2510 (.1278)	0.049	0.2039 (.1066)	0.056
Suspect apprehend w/ 10 minutes	4.1797 (.2661)	0.000	3.6688 (.1881)	0.000	3.8732 (.2385)	0.000	3.4732 (.1740)	0.000	3.8862 (.2376)	0.000	3.4854 (.1742)	0.000
Victim – Suspect Relationship	1.1786 (.1488)	0.000	.9811 (.1221)	0.000	1.2338 (.1314)	0.000	1.0463 (.1108)	0.000	1.2378 (.1310)	0.000	1.0473 (.1106)	0.000
Crime Type												
Homicide					1.6283 (.2266)	0.000	1.7548 (.2110)	0.000	1.6452 (.2645)	0.000	1.8046 (.2361)	0.000
Rape	1.0230 (.2222)	0.000	1.2836 (.2029)	0.000	1.0162 (.2085)	0.000	1.2253 (.1951)	0.000	1.0250 (.2058)	0.000	1.2363 (.1931)	0.000
Assault	1.2991 (.1951)	0.000	1.5480 (.1700)	0.000	1.2536 (.1815)	0.000	1.4704 (.1630)	0.000	1.2773 (.1818)	0.000	1.4979 (.1643)	0.000
Robbery	.8700 (.1848)	0.000	.8177 (.1691)	0.000	0.8141 (.1717)	0.000	0.7670 (.1630)	0.000	0.8402 (.1705)	0.000	0.7916 (.1624)	0.000
Burglary (reference)												
Demographics												
Non-White Victim	-0.1885 (.1278)	0.140	-0.4064 (.1104)	0.000	-0.2189 (.1175)	0.063	-0.4203 (.1032)	0.000	-0.2229 (.1175)	0.058	-0.4207 (.1031)	0.000
Non-White Suspect	.0433 (.1365)	0.751	.1940 (.1180)	0.100	0.1892 (.1200)	0.115	0.3224 (.1064)	0.002	0.1937 (.1205)	0.108	0.3269 (.1064)	0.002
Male Victim	-0.1655 (.1355)	0.222	-0.1474 (.1153)	0.201	-0.1268 (.1259)	0.314	-0.1057 (.1083)	0.329	-0.1218 (.1254)	0.331	-0.0983 (.1082)	0.364
Male Suspect	-0.3190 (.2686)	0.235	-0.2895 (.1865)	0.121	-0.3446 (.2471)	0.163	-0.3051 (.1780)	0.086	-0.3271 (.2465)	0.184	-0.2764 (.1774)	0.119
Location												
LA County	1.2383 (.1683)	0.000	1.3939 (.1362)	0.000	0.9584 (.1453)	0.000	1.1022 (.1231)	0.000	0.9632 (.1530)	0.000	1.1391 (.1273)	0.000
Indianapolis	1.2108 (.1670)	0.000	.9366 (.1392)	0.000	1.0151 (.1425)	0.000	0.8015 (.1256)	0.000	1.0367 (.1427)	0.000	0.8307 (.1253)	0.000
Constant	-3.5239 (.3205)	0.000	-3.4281 (.2462)	0.000	-3.3735` (.2929)	0.000	-3.3051 (.2333)	0.000	-3.3807 (.2942)	0.000	-3.3383 (.2345)	0.000
Pseudo R^2	0.3184		0.3469		0.3098		0.3333		0.3091		0.3320	