

# The Arson Research Project

## MEASURING THE IMPACT OF COGNITIVE BIAS IN FIRE INVESTIGATION



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The Arson Research Project is a criminal justice research project hosted by the Constitutional Law Center of Monterey College of Law. Our mission is to examine the reliability of evidence used in the investigation and prosecution of arson, and to identify convictions obtained secondary to unreliable evidence.

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## MEASURING THE IMPACT OF COGNITIVE BIAS IN FIRE INVESTIGATION

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### ABSTRACT

Cognitive bias has been found to shape decision making in a wide variety of fields. Criminal investigation and the forensic sciences are no exception.<sup>1</sup> Fire investigation, part criminal investigation, part forensic examination, is uniquely positioned to be influenced by the affects of cognitive bias.

The 2009 report from the National Academy of Science, *Strengthening Forensic Science in the United States; A Path Forward (NAS Report)*, recognizes conceptual bias as a factor in all forensic disciplines.<sup>2</sup> The *National Fire Protection Association Guide for Fire and Explosion Investigation (NFPA 921)* acknowledges these biases as a concern in fire investigation.<sup>3</sup>

This report will explore the most common forms of cognitive bias found in the field of fire investigation, review past research and give recommendations on how these biases might be minimized. It will also present the results of new research which sought to measure the influence of expectation and role bias in fire investigation. A companion report, "Case Study Review of Contextual Bias in Fire Investigation" is available at [www.Thearsonproject.org](http://www.Thearsonproject.org).

### RESEARCH STUDIES

The Arson Research Project conducted the first phase of a two-part research study in October 2011, designed to measure the accuracy with which fire investigators were able to recognize the presence or absence of an ignitable liquid on burn patterns through visual examination.<sup>4</sup> Although previously conducted fire behavior studies have shown that full room involvement secondary to flashover can create burn patterns and fire indicators similar to, and possibly indistinguishable from, the suspected burn patterns attributed to the presence of an ignitable liquid, a blind study using certified fire investigators to compare these burn patterns had never been conducted.

Burn pattern samples from four common flooring materials were created in a live-burn exercise.<sup>5</sup> The exercise consisted of burning four 12' by 12' furnished burn cells beyond flashover. Three of the burn cells were ignited without an ignitable liquid; the fourth burn cell was ignited after pouring approximately 90 oz. of paint thinner in the center of the room upon each of the four flooring materials. Twelve burn patterns were removed from the four burn cells; four from the area where ignitable liquid had been poured and eight from three burn cells where no ignitable liquid was present.

In November 2011, in association with the California Conference of Arson Investigators (CCAI), the burn samples, along with fire scene photographs and diagrams, were displayed at the CCAI semiannual training seminar. The photographs and diagrams showed where in the compartment the samples had been located relative to fuel packages, windows and doors. The volunteer participants were told that each of the burn patterns had been exposed to flashover conditions, but were not told the area of origin of the fires or which compartments had been ignited with or without an ignitable liquid.

Thirty-three certified fire investigators examined each of the burn samples and the associated photographs and diagrams and completed participant questionnaires.<sup>6</sup> Each questionnaire consisted of biographical questions and substantive questions regarding the examination of each burn pattern.

For each burn sample, the volunteer participants were asked to choose one of the following three conclusions:

1. This burn sample was created **in the presence of** an ignitable liquid.
2. This burn sample was created **in the absence of** an ignitable liquid.
3. The presence of ignitable liquid **cannot be determined** through examination of this burn pattern and the associated photographs and diagrams.

Additionally, for each burn sample, the participants were asked their “level of confidence” in their conclusion on a 0-10 scale.

Thirty of the thirty-three participants concluded the presence or absence of an ignitable liquid for all or some of the samples. Only three of the thirty-three completed questionnaires chose #3 (cannot be determined), for all twelve samples. On average, 66% of the responses were #1 (ignitable liquid present) or #2 (ignitable liquid absent), and 34% of the responses were #3 (cannot be determined).

Of the answers that determined the presence or absence of an ignitable liquid, 49.9% were a correct identification, and 50.1% were an incorrect identification. Because the random chance of correctly identifying the presence or absence of an ignitable liquid under these conditions is exactly 50%, the results of this portion of the study were consistent with a random guess.

The majority of the participants in this phase of the study were public sector fire investigators (fire department and police department investigators). Of the thirty-three participants, twenty-one (64%) were fire or police department investigators, and twelve (36%) were private sector investigators (insurance investigators, private investigators, engineers working for private companies).

In an effort to expand the number of participants, capture a greater number of private sector participants, and study the effect of a cognitive bias on a forensic examination, a second phase of the research was conducted in March 2012 in conjunction with the National Association of Fire Investigators (NAFI).

In the second phase of the study, the same burn patterns were examined by an additional 66 fire investigators. The group was separated into a control group (Group A-22 participants) and two treatment groups (Group B-19 participants, and Group C-22 participants). The control group was given the same questionnaire as participants in the first phase of the study and asked to determine through visual examination which burn patterns were created in the presence of an ignitable liquid and which were created in its absence.

The two treatment groups were given the following pre-questionnaire scenarios, designed to introduce expectation bias:

Group B received a scenario suggesting an incendiary cause, containing the following paragraphs:

Assume that each of the burn patterns you will be examining was removed from a fire scene involving a single family dwelling. The fire was first reported by the next door neighbor at approximately 02:30 hours. First responding engines found the living room, family room and bedrooms (the rooms where these samples were obtained) fully involved.

An eye-witness reported seeing a suspicious person walking through the gate to the side yard of the house carrying a sack approximately 10 minutes before flames were seen coming from one of the windows.

The two residents of the home were found dead in the master bedroom (not the room where any samples were obtained). Cause of death for both victims was determined to be smoke inhalation. Signs of forcible entry were found on the back door of the house.

Group C was given a scenario suggesting an accidental fire containing the following paragraphs:

Assume that each of the burn patterns you will be examining was removed from a fire scene involving a single family dwelling. The fire was first reported by the home owner/resident at 15:30 hours when she returned from the store after a one-hour shopping errand. First responding engines found the living room, family room and bedrooms (the rooms where these samples were obtained) fully involved.

The house was unoccupied at the time of the fire and there were no injuries or fatalities. The area of origin was determined to be the living room where there were several potential accidental ignition sources that could not be eliminated as the cause of the fire.”

The results of both control groups (33 participants from Phase I and 22 participants from Group A of Phase II) were separated between participants who worked for public agencies associated with law enforcement and those working in the private sector. The combined group of participants who completed the questionnaire absent biasing information was equally split between public and private sector investigators (28 public sector, 27 private sector).

## **COGNITIVE BIAS IN FORENSIC EXAMINATIONS**

Forensic Science is the study and practice of the application of science to the purposes of the law. A forensic examination, as discussed in this report, is the application of forensic science in an examination or investigation for the purpose of developing expert conclusions within a forensic discipline for use in court. As such, determining the origin and cause of a fire by examining the scene, observing and documenting fire patterns and burn indicators, as recommended in NFPA 921, for the purpose of presenting expert testimony in court, falls squarely within the definition of forensic science as applied in a forensic examination.

The goal of any expert testimony is to provide the trier of fact with relevant and reliable conclusions which due to the technical nature of the subject, the jury would not be able to deduce on their own. As a result, the reliability of the expert’s conclusion(s) is of critical importance.

In 1993, the U.S. Supreme Court released its ruling on the watershed case regarding the admissibility of expert testimony in federal court. In *Daubert v. Merrell Dow Pharmaceuticals, Inc.*<sup>7</sup> the court ruled that under Rule 702 of the Federal Rules of Evidence, which covers both civil trials and criminal prosecutions in the federal courts, a “trial judge must ensure that any and all scientific testimony or evidence admitted is not only relevant, but reliable.”<sup>8</sup> Under *Daubert*, the subject of an expert’s testimony should be based on scientific knowledge so that “evidentiary reliability will be based upon scientific validity.”<sup>9</sup>

The Supreme Court’s 1999 opinion in *Kumho Tire Co. v. Carmichael*<sup>10</sup> clarified “scientific testimony” applies to all proffered expert testimony, including technical or other specialized knowledge. It emphasized that reliability of the testimony must be judged by the specific circumstances of each case,

instead of globally in regard to the average dependability of conclusions in the forensic discipline in general.<sup>11</sup>

The *NAS Report* recognizes two crucial underpinnings in evaluating the reliability of forensic evidence: (1) the extent to which a particular forensic discipline is founded on reliable scientific methodology that gives it the capacity to accurately analyze evidence and report findings and (2) the extent to which practitioners in a particular forensic discipline rely on human interpretation that could be tainted by error, the threat of bias, or the absence of sound operational procedures and robust performance standards.<sup>12</sup>

Cognitive biases are subjective biases which undermine the reliability of evidence. An observer may have difficulty perceiving details and observations that run contrary to pre-established beliefs. At its most extreme, the presence of cognitive bias can cause the observer to see and record something that did not exist, or fail to see and record something that did exist.<sup>13</sup>

Expert conclusions influenced by bias should not be confused with an intentional desire on the part of the expert to proffer false testimony. On the contrary, the victim of bias is often unaware of its influence. This creates a unique situation where the expert witness providing unreliable testimony is harboring a false certainty in the accuracy of her conclusions.

This type of expert testimony, which is sincere but nevertheless incorrect, can be especially dangerous. In *The vision in 'blind' justice: Expert perception, judgment, and visual cognition in forensic pattern recognition*, Dror and Cole point out three special concerns regarding the influence of biased based expert testimony:

“(1) Cognitive biases affect all examiners in any forensic discipline; (2) Bias based expert conclusions are all the more powerful because the experts themselves believe them; (3) Many individual examiners – and more worrisome, many forensic professional bodies (both in the U.S and in Europe) – have been reluctant and resistant to acknowledge, accept, and take proper action to counter these biases.”<sup>14</sup>

Various circumstances conspire to make fire scene cause and origin investigation particularly susceptible to the affects of cognitive biases:

- (1) Fire pattern and burn indicator analysis, the key tools at the heart of most fire scene examination, are largely based on human interpretation. The ambiguous and ill-defined aspects of fire pattern/burn indicator analysis can be especially pronounced when flashover, ceiling collapse or extensive overhaul has occurred;
- (2) Fire scene examination is conducted in the field, rather than a laboratory, making the presence and influence of domain-irrelevant information difficult to control;
- (3) The mingling of cause and origin examination with criminal investigation, present in many public agency fire investigations, can introduce the effects of role bias.

As we will discuss, cognitive bias can be separated into sub-biases and effects each with somewhat unique influences. However, the sub-biases rarely occur in isolation and circumstances often implicate multiple biases. Where one bias ends and another begins is often unclear.

Even though this paper separates cognitive bias into discrete sub-biases (expectation bias, confirmation bias, etc.), the specific title attached to the bias is less important than their common result; a distorted conceptual framework leading to unreliable conclusions.

## **EXPECTATION BIAS**

When cognitive bias is formed by the pre-observation expectations held by the observer, the bias is termed *Expectation Bias*. Expectation bias is the tendency for experimenters to believe, certify, and express data that agree with their expectations for the outcome of an experiment, and to disbelieve, discard, or downgrade the corresponding weightings for data that appear to conflict with those expectations.<sup>15</sup> In other words, the observer's conclusions are contaminated with a pre-existing expectation and perception, reducing the observer's objectivity and laying the groundwork for selective attention to evidence.<sup>16</sup> The less instrumented and more subjective a forensic technique or measurement, the more it is subject to expectation induced errors.

Another important implication of expectation bias is the influence it plays on the amount of information or evidence necessary to reach the minimum threshold needed to form a conclusion. In the presence of a preformed expectation, observers tend to require less evidence to support a conclusion consistent with their expectation.<sup>17</sup>

In a study where prospective school teachers were asked to score exams of students being tested for academic readiness, researchers found that the information contained in a student's "background information" (which included student IQ scores) had a strong influence on how the exams were graded. Variations of final exam grades correlated with the expectations created in the minds of teachers by being exposed to domain-irrelevant data.<sup>18</sup> Students with higher IQ scores received higher scores than those with lower IQ scores for identical performance.

Recent cases and research involving fingerprint analysis provide particularly clear examples of the impact of expectation bias in forensic examinations. Fingerprint analysis, like fire pattern analysis, lacks clear instrumental measurement. In both types of examinations, the measuring instrument, in large part, is the examiner performing the analysis.<sup>19</sup> Reliance on human perception and interpretation of patterns, whether they be fingerprints, bite marks, tool marks, handwriting or fire patterns, is both common and concerning because expectation bias is most potent where the underlying analysis is subjective, ambiguous or ill-defined.

The erroneous fingerprint identification of Brandon Mayfield and the follow-up research based on his case clearly exposed the affects of expectation bias.<sup>20</sup> Brandon Mayfield was an Oregon attorney, arrested by the FBI and held as a material witness in the Madrid terrorist bombing case in 2004. His arrest was based on a misidentified partial fingerprint found at the crime scene in Madrid. The FBI fingerprint examiner's conclusions were confirmed by at least two additional FBI examiners as well as a fingerprint examiner hired by the defense. Two weeks after Mayfield's arrest the Spanish National Police matched the fingerprint to an Algerian, Ouhane Daoud, and Mayfield was released.

In 2006, the Mayfield case was used in a dynamic research study to measure the influence of expectation bias in the field of fingerprint analysis.<sup>21</sup> Five experienced latent print examiners were given a pair of prints which they were told were Mayfield's and the latent print from the Madrid bombing crime scene. None of the fingerprint examiners had ever seen these prints, but all were aware of the well publicized case. In this way, the five participants were provided with strong contextual clues that the prints, although visually similar, were not a match.

In fact, the examiners had been given sets of prints which each examiner had, years earlier in real criminal cases, concluded were matches. Examiners had before them two fingerprints that they had previously determined to have come from the same source; however, the expectation in the minds of the examiners was that the fingerprints were not a match.

The fingerprint examiners were asked to compare the prints and to ignore any additional contextual information (that the prints were from the Mayfield case and known not to be a match). Four of the five examiners contradicted their original conclusions; three changed from *identification* to *exclusion* and one changed from *identification* to *inconclusive*. Only one examiner maintained the original conclusion that the two prints came from the same individual.

A follow-up study using forty-eight pairs of fingerprints showed that expectation bias fostered by information such as “the suspect confessed to the crime” or “the suspect has an alibi” could influence examiners conclusions in both directions, towards *individualization* as well as toward *exclusion*.<sup>22</sup>

In fire cause and origin investigation, as in other forensic disciplines, expectation bias is caused by the examiner harboring an expectation prior to conducting the scene examination. The key ingredients of expectation bias are exposure to information which is *domain-irrelevant* and information which is *domain-relevant yet unreliable*.

As the name implies, *domain-irrelevant* information is data that may be relevant to the wider criminal investigation, but is not relevant to the forensic examination at hand. For instance, in the fingerprint study discussed above, the only domain-relevant information was the actual fingerprint images being compared. Any additional contextual information, such as “the suspect confessed to the crime” or “the suspect has an alibi”, was outside the domain of the fingerprint examiner. Although important factors in an overall criminal investigation, to the forensic examiner this extraneous information is *domain-irrelevant*.

Information which is *domain-relevant yet unreliable* – that is, information which is relevant to the forensic discipline in question but lacks scientific validation or reliability – can have the same impact on creating a preconceived expectation as domain-irrelevant information. In fire scene examination, flashover conditions create a unique environment where burn pattern interpretation can be particularly subjective and, at times, demonstrably unreliable.<sup>23</sup> These include the interpretation of irregular shaped fire patterns, concrete spalling or a perception that the fire burned abnormally hot or was “fast moving” as indications of the presence of an ignitable liquid, or the interpretation of various areas of deep charring as multiple areas of origin.

This is not to say that the expectation itself is not necessarily valid or reasonable. On the contrary, even a perfectly valid and well reasoned expectation can create the bias and be equally harmful to an otherwise objective examination. However, the role of the fire investigator, as a forensic examiner, is to draw expert conclusions within his discipline based solely on reliable, domain-relevant information.

When presented with expectation inducing domain-irrelevant information in The Arson Research Project study, participants were 12% more likely to conclude that ignitable liquid was present or absent (rather than select “undetermined”) even though the biasing information was not relevant to the task at hand.

The largest variation in response was amongst the treatment group provided domain-irrelevant information suggesting an accidental cause; members of treatment group C were 17% more likely to conclude an ignitable liquid was present or absent than the control group, with conclusions tending to correlate to the biasing information provided (accidental cause).

Treatment group B’s responses were 9% more likely to be a conclusion of the presence or absence of an ignitable liquid, and the specific conclusions were nearly identical to the control group’s (38% of the answers concluding an ignitable liquid was present, 62% concluding an ignitable liquid was absent).

## CONFIRMATION BIAS

A closely related phenomenon to expectation bias is confirmation bias. Often, the difference between the two is difficult to decipher. Confirmation bias is the tendency to search for or interpret information in a way that confirms the observer's preconceptions.<sup>24</sup> The hallmark of confirmation bias is the effort to bolster a hypothesis by seeking out evidence which supports the preconception, while dismissing contradictory evidence.

In research designed to measure the impact of confirmation bias in the field of criminal investigation, Barbara O'Brien and Phoebe Ellsworth asked participants to review and evaluate a file from a criminal case.<sup>25</sup> A portion of the group was asked to develop a hypothesis as to the suspect early in the case review while the other participants were not asked to specify a suspect.

The study showed that the simple act of naming a suspect early in the case review process tended to develop a bias in the minds of the participants which caused them to search for evidence thought to *inculcate* their named suspect, while tending to ignore or downplay equally *exculpatory* evidence. Moreover, participants who named a suspect tended to interpret ambiguous evidence in a manner consistent with their earlier conclusion.

In fire investigation scene examination, confirmation bias is commonly found in an examiner's use of quasi-scientific tools to bolster a suspicion of the presence of a liquid accelerant in the form of an ignitable liquid in support of a conclusion of arson. The use of accelerant detecting canines and hand-held ignitable vapor detectors provide cases in point.

NFPA 921 cautions against relying on the subjective behavior of an accelerant detecting canine, especially when laboratory samples of the item in question are returned as *negative* or *inconclusive* for ignitable liquid.<sup>26</sup> Yet, unconfirmed dog alerts have been admitted as evidence in criminal proceedings.<sup>27</sup>

Hand-held ignitable vapor indicators are used by various fire investigative agencies to support a suspicion of the presence of an ignitable liquid. Independent research conducted by The Arson Research Project has shown that one commonly used combustible gas detector is completely unreliable in a post-flashover fire, alarming on virtually any burned item or surface.<sup>28</sup>

The information provided by these techniques may help direct an investigative strategy and may save the examiner valuable time in narrowing down areas to examine more closely. They are not, in the absence of confirming laboratory analysis, evidence of the presence or absence of an ignitable liquid. They are at best presumptive tests requiring independent, objective, scientific corroboration.

Other particularly subjective analyses that have been used to confirm a finding of arson include the determination of *multiple areas of origin* in a fire that has reached flashover;<sup>29</sup> the use of "*negative corpus*,"<sup>30</sup> or process of elimination, to imply an intentional cause; and *fire modeling*,<sup>31</sup> where input data can be modified at the examiner's discretion, and the results calculated and recalculated until the anticipated results are created. These types of analyses provide the perfect environment for the forensic examiner to find evidence which confirms a preconceived hypothesis, while dismissing, diminishing or simply ignoring evidence to the contrary.

Like expectation bias, confirmation bias can be reinforced with either domain-irrelevant information or domain-relevant information which is unreliable. Often, a fire investigator exposed to these biases will confirm a preexisting expectation with additional clearly unreliable evidence.

## SELECTIVE RE-EXAMINATION

Perhaps the most elusive bias commonly found in forensic science is the use of selective re-examination to confirm a hypothesis, where the second, independent examination is conducted by an examiner who is (1) already aware of the conclusion drawn by the original examiner, (2) often made aware of the same domain-irrelevant information which tended to bias the original examination in the first place, and (3) there is a direct or indirect suggestion to the independent examiner as to the conclusion(s) he is expected to reach.

A statement by the Milwaukee County District Attorney in 2000 to the National Conference of the National Institute of Justice provides an example.<sup>32</sup> In his statement, he discussed a case where a police officer had been killed by a suspect's bullet. A state medical examiner concluded that the entry wound was in the police officer's back. This was consistent with the prosecution's theory that the police officer was not facing the suspect when the gun was fired. However, FBI examiners concluded that the bullet had entered the officer's chest. The FBI's conclusion was more consistent with the suspect's claim of self-defense, that the officer was facing the suspect and beating him when shot.

In an effort to resolve the dilemma, the district attorney re-contacted the FBI and told them that the state medical examiner had determined the entry wound to be in the victim's back, not his chest. He asked that the FBI re-check their findings. Armed with the knowledge that the prosecution's theory partially rested on the bullet entering the officer's back, and knowing that the state medical examiner's conclusions were consistent with this theory, the FBI changed its conclusions to match those of the state examiner.

This is the type of selective re-examination which leaves the preferred set of conclusions in place, and only questions the conclusions that do not support a particular theory. It is impossible to know how much of a role the extra, domain-irrelevant information played in changing the FBI's conclusion. The FBI's original conclusion, presumably based only on their forensic examination of the body and other relevant evidence, was that the bullet entered the officer's back, not his chest. After being made aware of the importance of the location of the entry wound to the prosecution's case, and knowing that a separate examination had resulted in a different conclusion, the FBI changed its mind.

In another case, this time involving fingerprint identification, the FBI took a set of two latent prints found at a crime scene, along with the known fingerprints of a suspect, and sent them to each of the fifty state crime laboratories.<sup>33</sup> An FBI examiner had already concluded that the suspect's prints matched both latent prints, and sending the evidence to the states' crime labs was apparently an attempt on the part of the FBI examiner to confirm their conclusion of a match.

Instead of providing confirmation, the attempt only made things more confusing. Seven of the responding labs failed to match one of the latent prints to the suspect, and five other labs failed to match the other.<sup>34</sup> The FBI then sent each of the labs that failed to find a match enlarged photographs of the latent prints and the suspect's print, along with annotations showing the ridge characteristics which the FBI examiner had relied upon in determining a match. As expected, most of the labs selected for re-examination changed their conclusions to be consistent with the FBI's conclusion of a match.

The use of selective re-examination and the potential biases which it infers is common in the field of fire investigation, particularly in the areas of confirming the *area of origin* and *multiple areas of origin*, and in the *exclusion of accidental heat or ignition sources*. Often, the second examiner is told the conclusions of the first examination and which possible ignition sources had been eliminated before the second, separate examination is conducted.

## **ROLE BIAS AND CONFORMITY EFFECT**

Research has shown that adopting a specific role can impact the observer's perspective and that the perspective of the observer has a direct impact on what information a person seeks, as well as how the information is perceived and processed. In a study where one group of participants assumed the role of a homebuyer and another group assumed the role of a burglar, the observations made by the different groups were starkly different, depending on the role the participant adopted.<sup>35</sup>

When a forensic examiner begins to embrace the role of a criminal investigator, the bias created from that change in perspective can shape the results of his analysis and conclusions. Some of the *NAS Report's* strongest recommendations and sharpest criticisms are directed toward the importance of a forensic investigator's independence from law enforcement:

“...forensic investigations should be independent of law enforcement efforts either to prosecute criminal suspects or even to determine whether a criminal act has indeed been committed.”<sup>36</sup>

The potential for a forensic examiner to reach bias induced conclusions when interacting closely with criminal investigators is enormous. In addition to adopting the perspective of a criminal investigator, a close alliance with law enforcement can alter the type of information to which a forensic examiner is exposed.

Consider the cases of Christopher Boots<sup>37</sup> and Eric Proctor<sup>38</sup> who were indicted in 1986 for a 1983 murder. Local police collected trace evidence (gunshot residue) from the crime scene. The police sent the evidence to the FBI crime lab in an attempt to tie the residue found on the victim to gunshot residue found on one of the suspects.

The following are excerpts from the letter which accompanied the evidence submitted for analysis:

“This is a murder case that took place in June 1983. The killer or killers entered a local 7-11 store in the late evening hours and forced the young male clerk into the back room (cooler) and broke a full 10 ounce bottle of Orange Crush over his head and then shot him in the head three times with a .22 caliber weapon (probably a Hi-Standard revolver). Due to some interagency problems the case to date has not been prosecuted, but will be soon...The flake was originally found on the trousers of one of our suspects. We want, if possible for you or Ed to compare this flake (B) to some partially burned flakes (A) found on the body of our victim...Request: If possible, please compare A to B. Time is of the essence now because of a lawsuit one of the suspects is bringing against the police department for false arrest. I would appreciate any help you can give.”

The resulting laboratory report was incriminatory. Boots and Proctor were convicted and incarcerated. Eight years later they were both exonerated when the real killer was identified through independent evidence.

The relevant question in this case is not the accuracy of the lab results, but the conditions under which the analysis was conducted. The request for laboratory analysis could have been written much more succinctly, absent the biasing information, by simply requesting that the two samples be compared. However, the tone and content of the letter implies that the police officer and the forensic examiner are on the same team. When a forensic examiner's role merges with that of law enforcement, the possibility that conclusions are being drafted to support the needs of law enforcement becomes problematic.

The affects of role bias can be compounded when there is pressure on the examiner to be in conformity with other investigators or examiners, or when one examiner relies on the views of others in order to develop what should be an independent conclusion.

Fire investigators can be especially at risk of assuming the role of a criminal investigator – in many jurisdictions this policy is officially endorsed. In place of the independence of forensic examination recommended in the *NAS Report* many public agencies have adopted the *Arson Task Force* model where the lines between fire scene examiner and criminal investigator are not just blurred but are obliterated.

*NFPA 921* does little to separate the two vocations. The chapter titled “Incendiary Fires” provides a list of indicators that an investigator may use in drawing a conclusion that the fire “has been deliberately ignited under circumstances in which the person knows the fire should not be ignited”.<sup>39</sup> In addition to *domain-relevant* evidence that may be found at the fire scene (incendiary devices, delay devices, indications of multiple fires, and others), the chapter contains a list of non-fire indicators. These factors (removal or replacement of contents, absence of personal items prior to the fire, evidence of other crimes, indications of financial stress, over insurance, owners with fires at other properties, and others) are *domain-relevant* to the criminal investigator, but are *domain-irrelevant* to the cause and origin examiner.

In no other forensic discipline is the forensic examiner expected to determine if a crime has or has not occurred, or to examine evidence outside the examiner’s area of expertise in order to identify a suspect, verify a suspect’s opportunity to commit the crime, or develop a motive. Only fire investigation, particularly as practiced in the public sector, has embraced the merger of forensic examiner with criminal investigator, seemingly unaware of the pitfalls this potential bias creates.

In The Arson Research Project study, participants who worked for public sector agencies (fire departments and police departments) were more likely to draw conclusions regarding the presence or absence of an ignitable liquid on the burn samples, even though there was no scientific bases for the conclusion. When the control groups from the CCAI and the NAFI studies were combined, public sector investigators were slightly more likely to chose that ignitable liquid was present or absent in all twelve of the burn samples (82% of public sector participants chose #1 or #2 for some or all of the samples, compared to 78% of private sector participants).

However, public sector investigators concluded the presence or absence of the ignitable liquid in far more of the samples than their private sector counterparts. Of those that concluded an ignitable liquid was present in some or all of the samples, public sector investigators made that conclusion 64% of the time compared with 48% for the private sector participants. Conversely, public sector investigators chose #3 (undetermined) 36% of the time, compared with 52% for the private sector.

## **THE EFFECT OF CERTAINTY ON ACCURACY**

The correlation between the *certainty* of a conclusion and the *accuracy* of the conclusion has been the subject of research in many fields. In one study, horse-race handicappers were asked to predict the winner of a horse race and to state how confident they were in their predictions.<sup>40</sup> After providing their initial predictions and confidence levels, the participants were given additional information on the horses, the jockeys, race conditions and so forth. With the additional information the handicappers were asked again for predictions and confidence levels. As they continued to get additional information which they could use to create predictions, their confidence level increased, but the accuracy of their predictions did not.

Historically, fingerprint examiners have shown a very high confidence level in a particularly ambiguous field. Fingerprint analysts regularly testified to 100% accuracy and their conclusions were rarely

questioned.<sup>41</sup> However, recent cases of misidentification involving fingerprint evidence, including the case of Brandon Mayfield, discussed above, have begun to expose a gap between the confidence of its experts and the underlying accuracy of the discipline. In a 2007 death penalty trial, a Maryland judge excluded the testimony of a fingerprint examiner that a latent print was made by the defendant, ruling that traditional fingerprint analysis was “a subjective, untested, unverifiable identification procedure that purports to be infallible.”<sup>42</sup>

In The Arson Research Project study, confidence levels differed between public sector and private sector investigators. In the CCAI study, public sector participants were 14% more confident than private sector investigators (CCAI public sector average confidence = 7.3, CCAI private sector average confidence = 6.8). The spread between the public and private sectors in the NAFI study was more dramatic, with law enforcement participants 30% more confident in their conclusions than non-law enforcement participants (NAFI control group, public sector average confidence = 7.8, private sector average confidence = 6.0).

## CONCLUSIONS AND RECOMMENDATIONS

The research conducted by the Arson Research Project represents just one step in examining the impact of expectation and role bias in fire scene examination. Although preliminary, the results of the study begin to provide a glimpse into important aspects of fire investigation methodology and practice.

Research results from the first phase were twofold:

- (1) Fire scene examiners were unable to accurately determine the presence or the absence of an ignitable liquid on burn samples from post-flashover fires through visual burn pattern analysis. Attempts to do so are no more accurate than a random guess; and
- (2) In spite of two decades of research and training to the contrary, many experienced fire scene examiners still apparently believe that the presence or absence of an ignitable liquid can be determined through visual examination of the remaining burn patterns in a post-flashover environment.

Results of the second phase suggest the following:

- (1) When compared to a control group, participants exposed to biasing information were more likely to determine that an ignitable liquid was either present or absent in at least some of the twelve burn samples, and they made this determination more often than those in a “context free” environment; and
- (2) Public sector investigators were more likely to determine an ignitable liquid to be present or absent than private sector investigators and expressed a higher level of confidence in their conclusions.

These results begin to reveal several intertwined factors common in fire scene examinations. Fortunately, implementation of safeguards in these areas are fairly straightforward.

*Minimizing Bias by Shielding Fire Investigators from Domain-Irrelevant Information:* The current framework for fire scene examination, specifically as conducted in the public sector, is ripe for exposing fire investigators to ancillary information that is neither within their forensic domain nor relevant to the purpose of the examination which they are tasked to perform. Policies should be developed that will protect the cause and origin investigator from this type of information.

In those circumstances where, in spite of policies to the contrary, a fire scene examiner is exposed to biasing information there should be a system in place for the examiner to recue herself from the investigation and be replaced with an examiner that has not been exposed to the biasing information and is able to conduct the investigation in a context-free environment.

*Minimizing Bias by Training Fire Investigators Not to Rely on Unreliable Information:* NFPA 921 warnings notwithstanding, a belief amongst many fire investigators that visual examination of fire patterns in a post-flashover environment can be used to determine the presence or absence of an ignitable liquid still holds traction. Additional training is needed in this area.

The subjective nature of some current investigative techniques regarding post-flashover fires presents a special training concern. These techniques must be closely scrutinized to insure that the fire investigation community is not replacing one set of unreliable indicators (“pour” patterns, spalled concrete, “abnormal heat”, etc. to determine the presence of an ignitable liquid) with another (fire modeling and fire dynamics analysis to determine multiple areas of origin).

Furthermore, additional training and independent research addressing the true reliability and usefulness of accelerant detecting K-9s and hand-held combustible gas indicators is warranted.

*Minimizing Bias Through Context Free Secondary Examinations:* Secondary examinations must be conducted in an environment free of contextual biasing information, where expert conclusions are based only on evidence relevant to the secondary examiner’s area of expertise. When requesting a secondary examination, policies should be in place to shield the secondary examiner from potentially biasing information and the conclusions of previous examiners.

*Minimizing Bias by Separating Fire Scene Examination from Criminal Investigation:* Separating the role of the fire scene examiner from that of the criminal investigator is perhaps the single most critical improvement to current fire investigation methodology and almost certainly the most difficult to accomplish. The current culture of the public sector fire investigator participating in both the scene examination and the wider criminal investigation is well entrenched. The formation of teams made up of fire department cause and origin examiners with police detectives specializing in arson investigation in an *Arson Task Force* model is especially problematic as it tends to reinforce the overlap of the two vocations rather than separate them.

It is crucial to an objective forensic analysis that the two roles be separate. A forensic examiner conducting a fire scene examination for the purpose of determining the area of origin and causation of a fire simply may not participate in any parallel or subsequent criminal investigation based directly or indirectly on his cause and origin conclusions.

Put more directly, a fire scene cause and origin examiner may not act as a criminal investigator on the same case. To ignore this simple rule is to disregard the recommendations contained in the *NAS report* and sacrifice the real and perceived objectivity at the heart of a reliable and professional forensic analysis.

## **ABOUT THE AUTHOR**

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- <sup>2</sup> NAS Report, *Strengthening Forensic Science in the United States, A Path Forward* (2009), at 122.
- <sup>3</sup> NFPA 921, *Guide for Fire & Explosion Investigation*, sec. 4.3.8 and 4.3.9, (2011), at 18.
- <sup>4</sup> See generally, P. Bieber, *Fire Pattern Analysis and Case Study Review*, The Arson Research Project, [www.the arsonproject.org](http://www.the arsonproject.org).
- <sup>5</sup> *Id.*
- <sup>6</sup> Original participant questionnaires and complete study results on file with the author.
- <sup>7</sup> 509 U.S. 579 (1993).
- <sup>8</sup> *Id.* at 589.
- <sup>9</sup> *Id.*
- <sup>10</sup> 526 U.S. 137 (1999)
- <sup>11</sup> See generally D. Michael Risinger, Defining the "Task at Hand" *Non-Science Forensic Science after Kumho Tire v. Carmichael*, 57 Wash. & Lee L. Rev. 767 (2000)
- <sup>12</sup> See *NAS Report*, supra note 2, at 9.
- <sup>13</sup> For specific examples of error resulting from observer effects in science, see generally Alexander Kohn, *False Prophets* (rev. ed. 1989)
- <sup>14</sup> See *The vision in "blind" justice*, supra note 1, at 162.
- <sup>15</sup> M. Jeng, *A selected history of expectation bias in physics*, *American Journal of Physics*, 74 (7): 578 (2009) at 583.
- <sup>16</sup> For more information on expectation and perception, see generally U. Neisser, *Cognition and Reality: Principles and Implications of Cognitive Psychology* (1976).
- <sup>17</sup> For more information on decision thresholds, see Victoria L. Phillips, James M. Royer & Barbara A. Greene, *The Application of Signal Detection Theory to Decision-Making in Forensic Science*, 46 J. Forensic Sci. 294, 296 (2001)
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- <sup>20</sup> See generally, *A Review of the Handling of the Brandon Mayfield Case*, Inspector General Special Report (2006), available at [http://www.justice.gov/oig/special/s0601/PDF\\_list.htm](http://www.justice.gov/oig/special/s0601/PDF_list.htm).
- <sup>21</sup> See *The vision in "blind" justice*, supra note 1.
- <sup>22</sup> *Id.*
- <sup>23</sup> See *Fire Pattern Analysis*, supra note 4.
- <sup>24</sup> M. Oswald, S. Grosjean, "Confirmation Bias" in *Cognitive Illusions: A Handbook on Fallacies and Biases in Thinking, Judgment and Memory*, Psychology Press (2004), 79-96.
- <sup>25</sup> See generally, O'Brien, B., Ellsworth, P., *Confirmation Bias in Criminal Investigations*, University of Michigan (2006).
- <sup>26</sup> See *NFPA 921*, supra note 3, sec. 16.5.4.7 through 16.5.4.7.6, at 150-151.
- <sup>27</sup> See *Fones v. State*, 765 So.2d 849, 850 (Fla.App.2000); *Reisch v. State*, 1993 WL 227264, \*2, 1993 Del.Lexis 229 at \*4-6 (1993); *State v. Buller*, 517 N.W.2d 711, 712-14 (Iowa 1994).
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- <sup>29</sup> See generally, S. Carman, *Improving the Understanding of Post Flashover Fire Behavior; Progressive Burn Pattern Development in Post-Flashover Fires*, available at [www.carmanfireinvestigations.com](http://www.carmanfireinvestigations.com).
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- <sup>33</sup> *United States v. Mitchell*, No. Crim. #96-407-1 (E.D. Pa. 2000).
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- <sup>37</sup> *State v. Boots*, 767 P.2d 450 (Or. Ap. 1989), *rev'd*, 780 P.2d 725 (Or. 1989).
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- <sup>42</sup> *State of Maryland v. Bryan Rose*, In the Circuit Court for Baltimore County, Case No. K06-545.