

Reliability of Eyewitness Statements in Fire and Explosion Investigations

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Abstract—While fire and explosion incidents are often observed by eyewitnesses, the weight that fire investigators should place on those observations in their investigations is a complex issue. There is no doubt that eyewitness statements can be an important component to an investigation, particularly when other evidence is sparse, as is often the case when damage to the scene is severe. However, it is well known that eyewitness statements can be incorrect for a variety of reasons, including deception. In this paper, we reviewed factors that can have an effect on the complex processes associated with the perception, retention, and retrieval of an event. We then review the accuracy of eyewitness statements from unique criminal and civil incidents, including fire and explosion incidents, in which the accuracy of the statements could be independently evaluated. Finally, the motives for deceptive eyewitness statements are described, along with techniques that fire and explosion investigators can employ, to increase the accuracy of the eyewitness statements that they solicit.

Keywords—Explosion, eyewitness, fire, reliability.

I. INTRODUCTION

EYEWITNESS statements are frequently an important element to a wide range of criminal and civil investigations. This is especially true in situations in which there is little or no physical evidence available to investigators. In criminal investigations, the only evidence of an alleged crime may be an eyewitness who identified the perpetrator. Similarly, in fire investigations the fire may have caused so much damage to the physical evidence that eyewitnesses could potentially play an important role in evaluating features of the fire, including where it originated. In this paper, we begin by describing the perception, retention, and retrieval processes associated with memory along with factors that can influence these processes and the associated accuracy of eyewitness statements. Then, we review data in the literature concerning the accuracy of eyewitness statements from real-world incidents, including fires and explosions, as these are the type of statements that fire investigators are most likely to receive. While even honest eyewitnesses may provide inaccurate statements, the various motives that may be present in fire and explosion incidents for deceptive eyewitness statements are also described. Finally, the implications of potentially inaccurate eyewitness statements, due to error or deception, in fire and explosion investigations are discussed along with techniques that fire investigators can utilize to increase the accuracy of eyewitness statements that they solicit.

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II. FACTORS THAT AFFECT EYEWITNESS RELIABILITY

The manner in which an eyewitness perceives, retains, and recalls an event is a complex process and has been the subject of extensive research. Since the 1970s, thousands of papers have been published in this area. While the factors that affect perception, retention, and retrieval processes are quite diverse, a summary of some of the most important factors for witnesses of fire and explosion events are shown in Table I [1]-[5].

TABLE I
SUMMARY OF SOME FACTORS THAT AFFECT EYEWITNESS RELIABILITY

Factor	Effect
	Perception
Lighting	Poor lighting, obstructions, or low contrast reduce accuracy
Conditions	
Attention	Reduced accuracy on items witness was not focused on
Involvement	Shorter duration or lower involvement generally reduces accuracy
Stress/Fear	Generally reduces accuracy
Age	Children and elderly generally less accurate
Expectations	Generally reduces accuracy
Drugs and Alcohol	Generally reduces accuracy
Training	Generally no difference between law enforcement and civilians
CO Inhalation	Reduced accuracy starting at 18-25% COHb
Time Awake	Reduced accuracy for up to two-four hours after waking
	Retention
Length of Retention	Longer time from incident generally reduces accuracy
Post-Event Information	Memory often distorted to conform with new information
	Retrieval
Method of Questioning	Can strongly influence the retrieved memory

Perception depends on the characteristics of the event and the witness making the observation. Factors such as lighting, obstructions, viewing location, and duration of the event affect one's ability to perceive it. The characteristics of the witness and their role in the event also influence perception. Factors such as attention, involvement, stress/fear, age, expectations, drug or alcohol use, CO inhalation, and time awake can all influence perception.

Once an event is perceived, the retention process begins. This process is dependent on the witnesses and what information they deem most useful to them at some point in the future. As a result, two witnesses may perceive the same event but have different memories because they each deemed different aspects of the event to be important. Even if an event is retained,

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memory is lost over time and is vulnerable to interference from any post-event information received. If the new information is true, it can serve to “inoculate” against forgetting. However, if the information is incorrect, it can become integrated into the person’s recollection of the event. There is extensive potential for this sort of erroneous supplementation in most (if not all) accident and crime scenes [2]. This effect can be so strong that even highly confident witnesses may be incorrect [6].

Retrieval is the final process to obtain information from a witness about an event. The retrieval process is highly susceptible to being altered by the circumstances of the retrieval [2]. Improper retrieval techniques, such as leading questions or asking questions that provide information to the witness about the event, can significantly alter the retrieved memory.

III. RELIABILITY OF EYEWITNESS OBSERVATIONS IN REAL-WORLD INCIDENTS

While there are a substantial number of studies involving well-controlled laboratory conditions, assessment of the accuracy of eyewitness observations from real-world crimes, fires, explosions, and other major accidents are particularly relevant to fire investigators. These real-world studies inherently take into account all of the factors that may reduce the reliability of eyewitness statements, as shown in Table I. As a result, these studies are indicative of the accuracy of witness statements that a fire investigator could receive.

The accuracy of eyewitness observations, in real-world events, can vary dramatically. English and Kuzel [7] studied eyewitness observations of American Airlines Flight 587 (AA587) crash that occurred on November 12, 2001, and compared those observations to the conclusions of the National Transportation Safety Board (NTSB) investigation. A few minutes after taking off from JFK airport in New York, Flight 587 violently pitched down and crashed into the middle of a residential neighborhood of Belle Harbor, a suburb of Queens, New York. The NTSB concluded that the probable cause of Flight 587’s accident was co-pilot rudder input that resulted in the vertical stabilizer breaking off from the fuselage and falling into Jamaica Bay. The loss of the primary aerodynamic flight control surface and substantial change in center of mass caused the jet to pitch down and dive towards the ground. The NTSB also concluded that the engines themselves suffered no in-flight fire and there was no other pre-impact fire.

As part of the investigation, 354 witnesses provided statements with sufficient detail about their observations to be documented by the NTSB. English and Kuzel [7] then eliminated from this population witnesses who were many kilometers from the crash site or who were moving on boats, trains, planes or whose position was otherwise unknown, resulting in a dataset of 239 statements. Of these 239 statements, 183 witnesses expressed an opinion about whether or not the plane was on fire before impact. Of the 183 witnesses with an opinion, only 65 (36%) correctly stated that there was no fire whereas 118 (64%) incorrectly stated that there was fire. In this case, the majority of eyewitnesses, 64%, were wrong and only 36% were correct. English and Kuzel [7] performed a statistical analysis to determine if these results were dependent

on the geographic location of the witness and found no correlation. Of the witnesses who incorrectly reported a fire, there was no consistent location in which they stated that they observed the fire. These witnesses reported that the fire was located: 7% right engine, 7% right wing, 6% tail, 41% fuselage, 9% left engine, 17% left wing, 14% miscellaneous area, 4% in an undefined wing, and 4% in an undefined engine.

In contrast to the results of English and Kuzel [7], Woolnough and MacLeod [8] observed high eyewitness accuracy from eight violent crimes caught on security cameras. In this study, details of each incident were gathered from statements contained in police reports. It is unclear if these statements were written statements provided by the witnesses, or if a police officer questioned the witness and then recorded the responses. The results of the study were that witness statements in the police reports were 96% accurate compared to the security camera video. The authors noted that the high accuracy may have been due to the fact that the crimes involved dynamic behavior between two individuals and that there was a threat of personal injury, which may have the effect of ensuring a high level of attention and cognitive processing. Since the information source was police reports, these statements were likely made immediately after the incident, but it is unclear if the witnesses were exposed to new information provided by outside sources prior to the police statement. It is also unclear as to the approach used to gather the statement from each of the eyewitnesses.

Nachson and Slavutskay-Tsukerman [9] evaluated eyewitness statements from an explosion at the entrance to the Dolphinarium discotheque in Tel Aviv on June 1, 2001. The blast killed 21 people and injured another 103. In this study, a total of 55 people provided eyewitness accounts by answering a questionnaire that was administered two years after the incident. Of the 55 participants, 17 had been injured by the explosion, 18 had witnessed the explosion with no injuries, and 20 were not present at the site of the explosion. The “true sequence of events” was taken from two leading dailies (*Yediot Ahronot* and *Ma’ariv*) published two to three days after the incident and Limpert’s book *Dolphinarium: Here we dance*, which was published a year after the incident. Only details that were consistent between the three sources were selected for evaluation of the accuracy of the eyewitness accounts. The injured victims, eyewitnesses, and control groups answered the questions accurately 61%, 58%, and 43%, respectively, and conversely, were wrong 39%, 42%, and 57% of the time, respectively.

Riniolo et al. [10] evaluated the accuracy of eyewitness statements of survivors of the *Titanic*. Such an evaluation was made possible by new forensic evidence by Garzke et al. [11] in which there was “no doubt” that the main hull of the *Titanic* was breaking apart while the ship was still on the surface of the ocean. The eyewitness testimony was then compared to this forensic evidence. The results were that 15 (75%) of the 20 eyewitnesses were correct in reporting that the hull was breaking apart while on the surface. The remaining five eyewitnesses (25%) were incorrect in their observations that the hull was intact.

Hjelmsater et al. [12] studied eyewitness statements associated with the sinking of the *M/V Estonia*. Similar to the [8], the authors did not ask any of the witnesses questions directly. Instead, they reviewed witness interviews that were conducted within one week of the accident. There were only a few testable facts in which the eyewitness testimony could be compared to. The first was the list direction prior to sinking. Of those that had an opinion, 86% were correct, and 14% were incorrect. The other was if the bow or stern sunk first. On this issue, 76% were correct that the stern went down first, and 24% were incorrect.

The advent of DNA testing technology in the 1990s provided independent forensic data to compare with the information used in past criminal convictions, including eyewitness testimony. One of the most thorough investigations of exonerations using DNA evidence was by Garrett [13]. In evaluating the first 250 cases where the individual that was convicted was later exonerated by DNA evidence, 190 (76%) of these cases involved eyewitness identification in which one or more eyewitnesses falsely identified the defendant. In 36% of the DNA exonerations cases, multiple eyewitnesses falsely identified the defendant. In one of these cases, there were five eyewitnesses that all falsely identified the defendant. In these cases, the kind of evidence used for the conviction could have been anything. The fact that it happened to be eyewitness identification evidence illustrates that care must be taken when collecting and evaluating eyewitness accounts.

In response to the large number of exonerations which involved incorrect eyewitness testimony, the U.S. Department of Justice called for the development of national guidelines for the collection and preservation of eyewitness evidence for criminal cases [14]. This guide, which is entitled “*Eyewitness Evidence: A Guide for Law Enforcement*,” was published by the U.S. Department of Justice in October of 1999. In the monologue of this guide, U.S. Attorney General Janet Reno states: “Recent cases in which DNA evidence has been used to exonerate individuals convicted primarily on the basis of eyewitness testimony have shown us that eyewitness evidence is not infallible. Even the most honest and objective people can make mistakes in recalling and interpreting a witnessed event; it is the nature of human memory. This issue has been at the heart of a growing body of research in the field of eyewitness identification over the past decade” [15].

The potential for eyewitness testimony to be incorrect is both well-known and expected by researchers in the field. Buckhout [16] states: “Uncritical acceptance of eyewitness testimony seems to be based on the fallacious notion that the human observer is a perfect recording device – that everything that passes before his or her eyes is recorded and can be pulled out by sharp question or ‘refreshing one’s memory.’ My argument, as a psychologist, is that this is impossible because human perception and memory are decision-making processes affected by the totality of a person’s abilities, background, environment, attitudes, motives, and beliefs – and by the methods used testing recollection of people and events.”

Ainsworth [17] offers similar sentiments stating: “Even the most honest and upstanding of witnesses will inevitably

produce their own subjective and personal version of ‘the truth’...human perception and memory are not literal and objective recorders of ‘fact’. Rather these processes are personalized and subjective interpreters and recorders of information... Is it realistic to expect a witness to tell ‘the whole truth’? Such an expectation assumes that witnesses are capable of taking in every small detail of the scene which they witnessed, and of storing these details accurately and fully. But surely this is naive and unrealistic? Humans are simply incapable of taking in all the information which they encounter. Perception is selective in what it attends to, and large amounts of detail simply go unnoticed.”

IV. DECEPTION

The discussion concerning the accuracy of eyewitness statements heretofore has assumed that the eyewitnesses involved were unbiased and attempted to provide accurate information but, due to a number of factors, including those shown in Table I, may have been incorrect. However, as described by Redsicker and O’Connor [18], fire investigators may also encounter witnesses who are intentionally deceptive: “Investigators must often deal with respondents who lie during an interview. One might expect the person to lie only when he or she has a vested interest in the outcome of the case. In fact, complainants, witnesses, and even victims lie in their conversations with authorities.”

TABLE II
 MOTIVES FOR LYING

Description
To avoid being punished (for a misdeed or for an accidental mistake)
To obtain a reward not otherwise readily obtainable
To protect another person from being punished
To protect oneself from the threat of physical harm
To win the admiration of others
To get out of an awkward social situation
To avoid embarrassment
To maintain privacy
To exercise power over others by controlling information

The motives for lying have been studied by numerous researchers [19]-[21]. Ekman [21] describes nine motives to lie which are summarized in Table II. In fire or explosion cases, which can involve significant collateral damage, injuries, or even fatalities, witnesses that played a role in causing the event, and are therefore potentially liable for the damages and injuries, have significant motive to be deceptive. When insurance coverage is involved, some witnesses may mistakenly believe that if they accidentally caused a fire, their insurance may not cover the loss or, even if it does, they may lose their insurance. In some cases, the witness may be underinsured and have a direct financial interest in the outcome of the investigation. Witnesses may also mislead investigators because they are embarrassed that their careless act caused the fire. For example, a smoker that discards a cigarette in a trash can and then later observes a fire start in the trash can, may tell investigators that they first observed the fire in a location other than the trash can. They may do this to alleviate their responsibility for the fire, to

financially gain from the fire being caused by something else, or because they feel embarrassed that their careless act caused the fire. Similarly, a friend or spouse of the smoker may also provide deceptive testimony to protect their friend or spouse from punishment, embarrassment, or for their own financial gain.

V. DISCUSSION

There is no question that eyewitness observations can provide both accurate and important information to investigators, in both civil and criminal settings. Information from eyewitnesses has been useful in understanding numerous high-profile fire incidents [22]-[27]. However, it is also clear from the literature, including studies from real-world incidents and criminal cases, that even honest, well-intentioned, eyewitness statements can be incorrect. In the studies described above, the real-world accuracy of eyewitness statements ranged from 96% to 36% accurate. The potential for deceptive statements, for which there is often significant motive in fire and explosion incidents, provides another avenue for incorrect eyewitness statements.

Since accurate eyewitness statements are not assured, it is important for fire investigators to consider that eyewitness statements are incorrect when developing and testing various hypotheses. In some cases, there may be other types of evidence, including physical evidence, to test the accuracy of an eyewitness statement, as recommended by the U.S. Department of Justice [15]. However, in cases with severe damage to the scene, as is often the case with fire and explosion incidents, the available physical evidence may be of limited value in evaluating an eyewitness statement. Assuming that an eyewitness statement is correct and then basing opinions about a fire or explosion on that assumption clearly puts the fire investigator at risk of reaching incorrect conclusions. Such an approach is consistent with confirmation bias, as described by Geiman and Lord [27].

The uncritical acceptance of eyewitness testimony can taint a fire or explosion investigation, particularly in the critical early stages of an investigation when information and physical evidence are being collected. Geiman and Lord [27] suggest that one approach to avoid jeopardizing the scene inspection due to inaccurate eyewitness statements is to process the scene before interviewing any eyewitnesses. With this approach, the possibility for confirmation bias due to an incorrect eyewitness statement during the scene inspection and excavation is eliminated.

While many factors that affect the accuracy of an eyewitness statement are outside the control of the fire investigator, key components of the retention and retrieval processes for eyewitness statements can be dependent on the fire investigator. One of the most important issues associated with the accuracy of eyewitness observations is exposure to post-event information. This new information can distort an eyewitness's memory so as to conform with the new information, regardless of whether or not this information is correct. The U.S. Department of Justice [15] suggests to "Separate witnesses and instruct them to avoid discussing details of the incident with

other witnesses" and to "Encourage the witness to avoid contact with the media or exposure to media accounts concerning the incident." It also states that all emergency responders from the 911 call-taker to the officers at the scene should obtain information in a nonsuggestive manner by asking open-ended questions and avoiding leading questions. Clearly, a fire investigator or first responder telling an eyewitness his or her opinion concerning the fire would be counter to these principals and could create inaccurate eyewitness statements.

Fire investigators also have control over the interview process with eyewitnesses. It is generally accepted that utilizing the concepts of the cognitive interview is the best approach for interviewing eyewitnesses, as it produces more, and higher accuracy information than other techniques [28]. This approach is the recommended technique for criminal investigations [15] and is what is being taught to law enforcement officers who are training to become detectives [29].

The key element of the cognitive interview is obtaining a broad, unprompted, open-ended statement from the eyewitness [15], [28], [29]. This statement can be a written statement from the eyewitness, or it can be an electronically recorded verbal statement, or it can be dictated to the investigator, who writes it down, being careful to write down exactly what the eyewitness said word-for-word. Once in written form (or transcribed from the electronically recorded verbal statement), this statement can be used by any subsequent investigators, including by those trained to detect deception. It can also form the basis for the investigator to ask more specific questions concerning what the eyewitness included in the initial statement. Any questions asked of the eyewitness, whether they are specific or open ended, should be documented as well. Documentation of the question, in addition to the response, provides any subsequent investigators with the same information as the initial investigator and should allow similar conclusions to be drawn.

Other features of the cognitive interview technique include asking witnesses about their activities the day of the incident or the feelings they had throughout their activities. Note, however, that the interviewer should not rely on a self-assessment of emotional state [30]. Rather, the interviewer should ask questions that can be used to assess a witness's emotional state. The cognitive interview also involves asking participants to report everything they can recall even if it is partial or incomplete. Even a trivial detail could act as a trigger for more key information. Another aspect of the cognitive interview involves instructing witnesses to recall the event from a variety of perspectives and to describe what other witnesses would have seen. Lastly, the cognitive interview encourages recalling the event in a different temporal order. Witnesses may remember more recent events better than earlier events, and they should be encouraged to recall backwards from the end towards the beginning [28]. This process aids in receiving the most accurate information possible from eyewitnesses and in determining if the eyewitness is being deceptive.

VI. CONCLUSION

While eyewitness statements can be a useful component in fire investigations, it is well known that the accuracy of

eyewitness statements can vary dramatically. In the real-world incidents described in this study, the accuracy of eyewitness statements varied from 96%-36%. Inaccurate eyewitness statements are not unexpected given the complex, fragile, processes associated with the perception, retention, and retrieval of memories. Deceptive statements, for which there is often significant motive in fire and explosion incidents, can also lead to inaccurate eyewitness statements. Since accurate eyewitness statements are not assured, it is important for fire investigators to consider that the eyewitness statements are incorrect as part of the investigation. Assuming that an eyewitness statement is correct, and then basing opinions about a fire or explosion on that assumption, clearly puts the fire investigator at risk of reaching incorrect conclusions. The large percentage of innocent people convicted based primarily on eyewitness testimony, but later exonerated by DNA evidence, is a compelling illustration of this point.

While some factors that affect the accuracy of eyewitness statements are outside the control of fire investigations, there are numerous ways in which fire investigators can improve the accuracy of the statements that they solicit. The first is limiting the post-event information that an eyewitness might receive from other eyewitnesses, the media or even the fire investigator themselves, so as to minimize the chance that this information becomes integrated into the eyewitness's memory. The second is to utilize a cognitive interview technique when gathering information from an eyewitness. This technique involves using a nonsuggestive approach to obtain an unprompted statement, which can also be used to detect deception. It also involves asking the witness to recall the events in a different order, such as reverse chronological order, and asking the witness to recall the events from another perspective or vantage point. These techniques have been shown to increase both the amount and accuracy of the information obtained.

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