Enhancement of fire scene investigations using Accelerant Detection Canines

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In the United States, the use of Accelerant Detection Canines (ADCs) to enhance the investigation of fire scenes is becoming increasingly popular. The usefulness of the ADCs is directly related to their ability to detect minute amounts of an ignitable fluid in complex sample matrices. Although unconfirmed indications may occur, a properly trained ADC can help pinpoint the location of residual ignitable fluids at the fire scene. ADCs help reduce the number of samples collected at the scene thereby reducing the amount for analysis in the laboratory and increasing the quality of the samples and the scene investigation. The collaborative efforts of the laboratory, the fire scene investigator, and the well trained ADC provide substantial benefits to fire and police agencies in the investigation of fire scenes.

Introduction of Accelerant Detection Canines

For centuries dogs have been used in hunting situations for their strong desire to search and their keen olfactory ability. These abilities have also been exploited in police and military situations. Their work began in the early 1900s as "police dogs" or "Canine (K-9) Units", assisting their trainer/handler in police situations [1]. During World War II, "M" dogs were utilized by the United States military for mine detection in Europe; explosives buried four feet underground could be detected even up to one year after burial [2] and explosives detecting dogs are today used worldwide. Other detector uses include searching for humans in disaster situations and criminal investigations, as well as searching for drugs.

In 1983, at the United States Department of Treasury Bureau of Alcohol, Tobacco, and Firearms (ATF), forensic chemist Richard A Strobel and explosives investigator/dog trainer Robert Noll extended the concept of using dogs to detect ignitable fluid accelerants [3]. This posed a new challenge to chemists and trainers because petroleum products, unlike explosives or drugs, are common and normal to everyday use (e.g. gasoline/petrol). In 1984 initial tests were performed very successfully with a yellow Labrador Retriever named "Nellie." These tests established the feasibility of training a dog to detect ignitable fluids.

In May 1986, a joint venture began between the ATF and the Connecticut State Police (USA) to train a black Labrador Retriever named "Mattie" [4]. By September 1986, Mattie was the first field operational dog having been trained on a variety of accelerants, and by May 1987, she had responded to and searched 41 fire scenes. With Mattie's assistance some of these cases resulted in arrests and convictions of suspects.

The increasing popularity and versatility of dog–handler teams means they are being used to complement and enhance fire scene investigations across the United States. In fact, US insurance companies are providing thousands of dollars to train law enforcement dogs in accelerant detection [5]. It has been estimated that there are over 200 dog–handler teams in use throughout the United States today [6].

Training

The dog of choice commonly (but not necessarily) employed is the Labrador Retriever. The breed's strong drive for searching, powerful endurance, and keen olfaction coupled with its gentleness with humans make the Labrador a good choice.

There are four "types" of trained dogs commonly employed. They differ with their alert mannerisms and their reward type. The alert can be defined as the physical movements or actions taken by the dog to notify the handler/partner that an item being sought has been found. Alerts may be passive, simply a point-and-sit motion towards the location of the target item; or the alert may be active, which consists of aggressive motions of dig-and-paw or dig-and-bite at the target location. The reward for responding and finding the item may be food, such as dry kibble, or play, such as a tug or chew toy.

Dog training requires imprinting and maintenance [4]. Imprinting involves four steps. First the dog is initialized with an accelerant odour. It is exposed to a known ignitable fluid odour, taught the mechanics of an alert and receives the reward. During this step the dog is learning operant conditioning: it learns that a certain behaviour (odour recognition) brings a desired effect (reward). Next, during nullification the dog is exposed to pyrolysis products; at this stage the dog learns to avoid alerting when no accelerant is present. Third, the dog is taught to discriminate between known accelerants and pyrolysis products by alerting only to appropriate samples. It is important to note that only positive reinforcement (reward) is used in each step. Lastly, verification of the dog–handler team is required through the use of blind studies, preferably with laboratory confirmation. This process is to insure that (i) the dog and handler are working well with one another, (ii) the handler is not influencing the dog to an alert and/or (iii) the dog is not merely alerting to receive the reward.

Once imprinting is complete, the dog is ready for field operation. Training, though, must never cease; maintenance must continue on a daily basis to keep the proficiency of the dog and the handler sharp. This requires daily and continual discrimination testing and periodic verification testing, working closely with the laboratory. Dogs, like humans, can get lackadaisical if they are not tested regularly. The reward systems of food and play actually help the handler accomplish testing. Rewards are only given when the dog alerts to an appropriate sample; therefore, the dog cannot eat or play on a daily basis unless it properly responds to its proficiency samples. Both training and maintenance records must be kept thoroughly to document the dog's (as well as the trainer's) progress and proficiency. This, obviously, is critical in the courtroom. Some state and federal agencies and national associations in the US have certification programmes for ADCs which regularly test the proficiency of the dog teams [7–11]. A passing score must be obtained for certification; failing scores may result in de-certification.

Research and Testing

Issues of sensitivity, selectivity and canine olfactory processes, and how the latter affects the former two, are being widely investigated and none of the issues have been fully investigated at this time. Kurz et al examined issues of sensitivity and selectivity in a recent article [12]. Using simple substrate matrices, such as unburned carpet squares, the dogs could detect as little as 0.01 μl of accelerants. On more complex matrices, such as partially burned carpet material, the dogs could detect as little as 0.1 μl of accelerants. Tindall and Lothridge, also examining sensitivity and selectivity, reported dog teams detecting 0.005 μl of gasoline on unburned cotton substrate [6]. These values are near the detection limits of typical methods used today for fire debris analysis. For example, passive charcoal strip adsorption followed by gas chromatography with a flame ionization detector (GC–FID) can reasonably detect 0.1–0.5 μl of accelerant in complex matrices. Some handlers have reported that dogs have superior sensitivity to laboratory instrumentation [13,14]. This may remain in debate, until the limitations of measuring devices are overcome and liquid dispensing abilities become smaller.

Although dogs have a powerful ability to discriminate between accelerants and pyrolysis products, this is not 100% accurate. With dogs, false positives (incorrect alerts on known samples) and unconfirmed indications (alerts on unknown samples which are not laboratory confirmed) are possible. One cannot have both superior sensitivity and superior selectivity, as one precludes the other in nature. It follows that if dogs are more sensitive than instrumentation, then it is unlikely that they are more selective than instrumentation as well.

Selectivity issues may be resolved if the dog olfactory processes were understood. Research is currently being conducted in this area. Results will be welcomed benefiting chemists, dog trainers and handlers and, most importantly, the triers of fact. Parallel inferences can be drawn between human and dog olfaction [15]. Human olfaction relies on neurochemical transmissions between the olfactory receptors in the nose and the cortex (brain). These neurochemical connections are random, but random in consistent and specific manners for specific odours. These specific yet random projections are recalled by memory. One can think of the cortex as a ball game scoreboard with lights and the neurotransmitters as the wiring. Each time an odour is detected by the nose, one or more lights are illuminated for each component of the odour in a random fashion. (Odours usually have a collection of components.) Because the brain is programmed for categorizing memory, it "remembers" the specific set of randomly illuminated lights as a particular odour. If by happenstance a complex mixture of odours is detected and the lights illuminated are the same lights as a previously learned odour, then a mistaken association could be made. This, in fact, is the case in humans; for example, many humans detect maple syrup odour when vanilla and coconut extracts are mixed together. Although maple syrup is not present, the olfaction and recognition process claims that it is.

In the complex environment of the fire scene, it is not unlikely that the complex mixtures of pyrolysis products present could confuse the dog's olfactory recognition. For example, the author has previously encountered a product which mimics the aromatic compounds in gasoline [16]. The pattern obtained, which is from a consumer end-use product, is almost indistinguishable from "winterized" evaporated gasoline based on gas chromatography with flame ionization detector (GC–FID); mass spectroscopy must be used to identify the residue. In the presence of complex pyrolysis products, it is unreasonable to expect the dog to discern such mimicry when GC–FID analytical techniques have difficulty. The dog's olfaction process is not at fault; one must recognize that this is a phenomenon of the biological detection and recognition capability of the dog. Once understood thoroughly, it can be adapted into better comprehension and higher quality training of ADCs.

Dogs at the Scene

The versatility and usefulness of dogs is in their ability to search a scene in ways previously unavailable. With their seek/hunt drive, they are useful for quickly searching both the interiors and exteriors of structures. Their size, agility and endurance make them exceptionally advantageous in collapsed structure fires, where the liquid accelerant residue could be buried, by providing access to areas not available to human searchers.

Electronic hydrocarbon detectors ("sniffers") have been available for some time, but they do not have the ability to discriminate between pyrolysis products and accelerants, both of which are largely hydrocarbon in composition. Compared to "sniffers" and humans, dogs assist by more accurate sample collection and better use of laboratory time. With properly trained and properly maintained dogs an alerted sample has a higher probability of containing an ignitable fluid accelerant than samples collected by human efforts alone. Dogs have the ability to pinpoint single or multiple areas of potential liquid accelerants to sub-microlitre amounts in complex matrices [6,12]. Tindall and Lothridge have shown that the accuracy of the dog's pin-pointing capabilities are as small as a few square inches [6]. Pinpointing single suspect areas allows for more precise evidence collection and multiple areas of interest may help establish multiple points of origin upon laboratory confirmation. Dogs also help in vehicle searches and container searches in fields and large areas. Passive alert dogs may be used for crowd or suspect searches, potentially locating individuals with ignitable fluid residues on clothing. Additionally, if multiple samples are collected from the scene, the containers can be "screened" by the dog prior to sealing; those giving strong positive alerts can be preferentially forwarded to the laboratory for further confirmational analysis. If a human investigator suspects a chemical incendiary or accelerant to which the dog is not formally trained, samples should still be submitted to the laboratory regardless of the dog's actions.

Once a suspect area or sample is located by a dog alert, it must be laboratory confirmed. The reasons for this have been outlined here and in other work [4,6,12,15–17]. Although false positives and unconfirmed indications do occur, some claim the dogs find accelerants in a range up to 90–95% of the samples submitted for analysis, called the "Rate of Confirmation" [18]. The rates vary depending on, but not limited to, the samples included in the calculation (i.e. casework samples vs. training samples); the training, maintenance, sensitivity and selectivity of the dog; and the laboratory's ability to identify accelerants. Over the last three years with three dogs having submitted samples, the author has corroborated dog alerts in 40–50% of the submitted cases (n=20) and in 15–20% of the submitted case samples (n=70). It should be noted that one of the dogs submitting case samples was trained on toluene, a compound found in a large percentage of fire debris samples. The dog may have "correctly" alerted to a product containing toluene, but the laboratory did not find an ignitable fluid residue pattern present. Therefore, the dog alert was documented as unconfirmed by the laboratory findings.

Concluding Remarks

It has been said that "Man's Best Friend May be the Arsonist's Worst Nightmare." To date, dogs certainly pose a serious threat to the potential for arsonists to succeed in their heinous actions. Accelerant Detection Canines cannot and should not be expected to prove arson; this task must remain in the hands of trained human investigators who examine multiple facets of a scene. Nor can dogs actually identify an ignitable liquid accelerant as present; dog olfaction and commercial product mimicry clearly prevent any statement of identification being made by a dog alert alone. But the properly trained and well maintained dog can pinpoint suspect locations, items and/or persons where an ignitable fluid accelerant may be present. Their selectivity is toward accelerants (and not pyrolysis products) and their sensitivity, so far, may exceed that of instrumentation. In the field they have proved to be one of the best investigative tools available to the fire scene investigator. From the laboratory perspective, they can save time and money in sample analysis by supplying fewer but higher quality evidence samples for processing. From the investigative perspective, they can save a great deal of time searching a scene and increase the quality of the sample collection and subsequent laboratory submission. Thus, the collaborative efforts of the dog, the fire scene investigator and the laboratory can provide substantial benefits to fire and police agencies in the investigation of fire scenes.

Future Considerations

Work is ongoing in the areas of sensitivity and selectivity of dog olfaction. As understanding of the olfactory processes increases, more will be learned about the true abilities of the Accelerant Detection Canine. In the US, there is a strong move toward validation and certification of dog–handler teams by external agencies, much like the forensic science community is doing with scientists in the US and the UK. As with any potentially hazardous occupation, long term occupational hazards of the dogs are also being evaluated.

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