Article

Scent as Forensic Evidence and Its Relationship to the Law Enforcement Canine

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Abstract: This paper examines the utilization of the police canine as a tool to discriminate certain types of scents (particularly narcotics, explosive devices, and accelerants), search for evidence, track suspects or endangered persons, and locate cadavers. Specifically, this paper examines the police canine's abilities and shortcomings while working "in the field" and in non-laboratory conditions. The role of the canine handler and the possibility of contamination are also examined.

Introduction

Law enforcement agencies frequently use specially trained dogs for a variety of important purposes to aid in the detection and deterrence of crime. The primary reason is that dogs are cost effective means for crime control [1, 2]. Dogs possess olfactory abilities that far exceed that of existing technology. Unfortunately, empirical evidence documenting how the canine uses these amazing olfactory skills is far from complete, and little scientific testing of law enforcement canines has been conducted [3].

Only through a review of the literature in a range of law enforcement functions can even a fuzzy picture of the nature of scent, as a

form of forensic evidence, be documented. The following review of the literature attempts to link the commonalities found in research of different disciplines and to form a better understanding of scent that will drive future research.

Origin of scent

Man has utilized the scenting power of dogs for thousands of years [4]. The ability of dogs (*Canis familiaris*) to detect human scent is strongly documented throughout the literature [4-14]. Human scent is composed of skin flakes, perspiration, skin oils, and gaseous components [5, 15]. Depending upon the task, police canines use different aspects of these components. When tracking the scent of a suspect, the canine follows the skin flakes and disturbances to ground vegetation. If it is an article recovery, the canine is detecting the skin oils of the suspect that have contaminated the object sought. Canines are capable of locating such objects (e.g., guns) up to 48 hours later [5].

Airborne scents from fatty acids in the skin oils allow the police canine to detect a hidden suspect [5,16]. According to Bryson,

> ...sweat glands produce perspiration as the body's temperature rises, also in response to emotional stimuli such as stress or fear. The eccrine sweat glands–located all over the body, but concentrated in the armpits, soles, and palms–react primarily to heat stimuli and emotional stress, and regulate the body's temperature. Factors such as age, race, sex, size, physical and psychological conditioning affect the amount a person sweats. Additional factors, such as food, clothing, and lifestyle, cumulatively affect the air or ground scent picture presented to the searching dog [6, pp 123-124].

Scent detection ability

Syrotuck [17] reported that a comparison of olfactory cell counts between humans and canines indicates that a dog's sense of smell should be at least 44 times better than that of a human's. Other researchers estimate the dog's sense of smell as 100,000 times greater than that of a human's [1]. It has been established that

dogs are able to distinguish the odors of different people [7,8], and it is believed the most probable advantage canines possess is scent discrimination, or the ability to distinguish one scent from another.

Williams et al. [18], at the Institute for Biological Detection Systems (Auburn University), found that training dogs to detect as many as ten odors did not cause deterioration in performance. Additionally, extensive periods of time (120 days) without refresher training were documented. Odor identification remained stable without maintenance. However, it should be noted that this took place under controlled conditions and even the authors note that modification of training techniques for work dogs was not recommended.

Scent discrimination

Scent discrimination is not a new concept. The first documented case of scent discrimination dates back to the reign of Pyrrhus (300-272 B.C.):

> ...A certain slave for some unknown reason had been done to death by two men when they met him on a lonely road. His dog, who was with him and sole witness, remained by the body. The King passed that way on a royal progress, and observed the animal by the side of the corpse, had his charioteers halt. "Bury the body," he commanded, "and bring the dog to me." Some time elapsed: the dog remained with his new master and accompanied him when he went to a review of his troops. As two of the soldiers marched smartly past, the animal flew at them with such a fury that he all but tore them to pieces. No further evidence was needed, for in order to escape from the dog, the criminals confessed to their guilt. [4, p 9-10)

Kalmus [7] demonstrated in his experiment that canines were able to discern the individual odors of seventeen men, women, and children. Given the scent from one person, the dog was instructed to locate an object (handkerchief) with the same scent. This same skill was then extended to locating the track of an individual. Kalmus hypothesized that scent discrimination between people "must be based on differences between complex mixtures of a number of chemical substances" [7, p 30].

Taslitz [19] challenged the reliability of the canine scent evidence and specifically attacked the concept of the scent lineup. He found that there was inadequate scientific support to maintain the standard required under Frye v. United States, which states that scientific evidence may be admitted at trial only after it has been generally accepted as trustworthy by scientists in that relevant field.

Tolhurst [9] devised a methodology for storing scent material as a form of physical evidence. Strict protocols for the collection and storing of scent objects allowed comparison at a much later date. Although anecdotal in nature, Tolhurst's theories regarding scent contamination drove later research by defining scent as evidence that must be protected if it is to be of use.

Settle et al. [10] studied the success rate of dogs identifying people by scent. Seven hundred scent samples were collected from a wide range of individuals, while seven dogs were trained to match human body scents. An 85% correct matching rate was determined. Of additional interest was the fact that some dogs did not perform well in the presence of observers and "the performance of most began to deteriorate when the handler became emotionally involved in the dog's scoring success" [10, p 1447].

Hargreaves [11] discussed the method for conducting a scent lineup, based upon a method pioneered by Dutch Canine Units. First, scent is collected at the crime scene. An object is carefully secured in an airtight container and protected as evidence. Scent has been preserved in this manner and used successfully up to three years later. Second, a lineup is prepared. Six stainless steel pipes are scented by the suspect and five other persons by holding them for five minutes. The pipes are then lined up on the floor. The canine is given the scent from the original piece of scent evidence and is instructed to locate a matching scent. A number of controls are used to ensure fairness:

1. The suspect and the five other individuals are the same sex and same race.
2. A second line of pipes is included (with no suspect scent) to preclude the possibility that the canine feels compelled to make a choice.

Schoon [12] examined the experimental designs used in four different scent identification lineups. A mixture of two designs led

to a 75% accuracy rate. A number of issues were identified from handler error to problems in the training of the dogs.

Schoon [13] proposed an improved method of scent lineup to determine reliability. The Performance Check method was designed to assess the dog's willingness to work, as well as to establish a strong control. The "check" person would handle an object and a trial lineup would be conducted in order for the dog to establish its ability to discriminate scent. If the dog was successful, then the real lineup would take place. The dog would be given the scent from the evidence, and the check person's scent would be included in the lineup along with the suspect's scent. Schoon found that many of the dogs were disqualified after the check phase (approximately 50%).

Wojcikiewicz [14] discussed the reliability of scent identification at a paper presented at the International Academy of Forensic Science. He found that scent lineups have been used in a number of countries since the 1960s and 1970s. Unfortunately, he found no established standard or uniformity. As a result, the evidentiary use of the scent lineup varies.

Article or evidence search

If someone touches an object, human scent transfers to that item [7]. Article recovery relies on the fact that the skin oils of the suspect have contaminated the object sought. The object contains a scent different than that of the surrounding area. According to Bryson, scent "diffuses away from objects with time" [6, p 220]. As time passes, the scent of the object begins to take on the odor of the surrounding environment. Although canines are capable of locating such objects (e.g., guns) up to 48 hours later [5], delays work against the dog [6].

Similar to an area search, the canine is brought downwind and directed to search the area. Or, items of evidence can be identified while the dog and handler are actively tracking a suspect [20]. According to Bryson [6], the dog indicates it has located an object by 'alerting' through one of the following behaviors:

1. Aggressive (digging or scratching)
2. Nonaggressive (sitting or lying down)
3. Complex (sitting and barking)

Tracking

Tracking is the ability of the dog, using his nose, to follow an invisible scent path to find a person [21]. As with other scent related functions, it is strongly affected by outside conditions:

- Temperature [6, 22, 23, 24]
- Humidity [2, 6, 25,]
- Differing amount of scent for each person [5, 6, 15]
- Wind [6, 21, 22, 23, 25, 26]

There is a certain amount of controversy regarding exactly what the dog actually smells when he is tracking [5]. Some feel that the dog is following the actual scent of the suspect [5, 15], although others believe that the dog is following the scent of crushed vegetation or ground disturbance [25], and others believe it is a combination of both [6]. Tracking evidence is accepted in 45 states provided the proper foundation is laid [27]. According to Hunt [28], a properly trained dog can successfully follow a trail that is up to ten days old.

Explosives detection

Police canines can be taught to detect a wide range of substances and their specific odors [5]. Explosives commonly detected include:

- Gelatin (dynamite or nitroglycerine gel)
- Nitroglycerin and ammonium nitrate
- TNT (trinitrotoluene)
- Smokeless powder
- C-4 or Flex-X (plastic explosive)
- Primer Cord

The explosives canine indicates his alert passively (sitting or lying down) and one study indicates a detection reliability of 95%, which is 40% better than a human searching for the same device [5]. The New York City Police Department conducted an evaluation of explosives detection dogs in an urban environment [29]. Two

dogs were used to locate different types of explosive packages. The success rate ranged from 65% to 80%. Another study of reliability [30] found that the dogs were 88% accurate for C-4 and 54% for TNT. However, small sample size (three dogs) and an admitted contamination error may have contributed to the low scores.

Williams et al. [31], at the Institute for Biological Detection Systems (Auburn University), found an average successful detection rate for discriminating specific odors in excess of 85%. They found that dogs learn to depend upon the most abundant vapor constituents of a substance for identification of that substance. Therefore, they learn to identify a substance (e.g., an explosive) by using only a few compounds.

Narcotics detection

According to Williams, "the dog and its handler remain the most widely used, broadly sensitive, accurate, fast, mobile, flexible, and durable system available for detecting illegal drugs and explosives" [31, p 1]. Narcotics detection canines indicate their alert passively or aggressively (scratching). A trained dog's alert can be used as probable cause to search or to obtain a search warrant [6]. The key issue in the establishment of probable cause is the documented reliability of the canine and handler [32, 33]. The drug detection ability includes (but is not limited to):

- Marijuana (*cannabis sativa*)
- Cocaine hydrochloride
- Crack cocaine (cocaine freebase)
- Heroin
- Methamphetamine

Like the other scent related functions, scent is affected by the turbulence as it is diffused from the source [6]. The scent odor from the narcotic drifts with the air currents [34]. If the narcotics are hidden within a motor vehicle, then scent may seep out through gaps as it is pushed by wind on the opposite side of the vehicle [23].

Waggoner et al. [35], at the Institute for Biological Detection Systems (Auburn University), set out to determine the threshold for

detection of narcotic odor. Four of five dogs in the study detected the odor of cocaine successfully 80%-90% of the time at 0.1 ppb, but success rates declined rapidly below 0.05 ppb. Additionally, humidity was identified as an intervening variable. When exposed to high humidity levels, the degradation of cocaine is much higher causing the production of methyl benzoate as a byproduct. Researchers were unsure as to the effect on the test dogs and suggested future studies of the effect of humidity levels on the detection of cocaine. However, Waggoner et al. stated that their article should "help maintain the well deserved credibility of the dog as a detection technology competitive with or superior to other detection technologies" [35, p 225].

Accelerant detection

The Bureau of Alcohol, Tobacco and Firearms (ATF) trained a Labrador retriever to detect accelerants, and reliability equaled or exceeded the laboratory instruments [6]. Unlike patrol dogs, arson dogs are 'imprinted' with accelerant odors using the Pavlovian technique, which means that the dog does not get fed unless it correctly detects the desired odor [27]. This method focuses the dog's survival drive to act as motivator to search regardless of the conditions [36].

The Tindall and Lothridge [37] study determined that of 42 accelerant detection teams, 60% performed without error. Missed accelerants made up the majority of errors (28 of 40), while 20% of all canines tested had false indications. Tindall and Lothridge determined that "a properly trained and maintained canine would be more sensitive and accurate than electronic devices for the same purpose" [37, p 57].

Kurtz et al. [38] studied the level of detection of certain accelerants by canines. Two dogs from the Illinois State Fire Marshal's Office were used for this study. Gasoline, kerosene, and isopar residues were detected at a level below that of laboratory instruments. False alerts were detected in charred carpet and styrene, but dogs were trained to ignore these spurious, but similar, scents in a process known as "proofing". Kurtz et al. [38] made special note of reliability problems in studies that involve animal responses:

1. It is subjective on the part of the handler as to what constitutes a positive alert.
2. Sampling protocols influenced results.
3. Canines are not all equal when it comes to their abilities.

Kurtz et al. [39], in a later study, examined the effect of background interference on the ability of canines to detect smaller amounts of accelerants. Thirty-four canines from the Canine Accelerant Detection Association were used for the study. A wide range of skill levels between the teams was detected. Burnt carpet background caused the largest number of "false alerts". As the quantity of the accelerant fell below a certain level (2μL), the dogs were less successful discerning accelerant from the background odor of other burnt material. Kurtz et al. [39] felt that field and training records would establish future credibility of dog teams.

Katz and Midkiff [40] studied the use of accelerant canines as reliable evidence in criminal proceedings. The issue at hand was the delay from the canine alert to the actual laboratory testing of samples for traces of accelerant. This delay can cause the evaporation of flammable liquid prior to analysis. In these cases, the alert of the canine, standing alone, could not be admitted as evidence. In other cases, no laboratory tests were ever conducted on the sample to verify the identification of accelerants made by the dog, and evidence provided by the canine was allowed to corroborate the testimony of the officers.

Katz and Midkiff suggest that, although the olfactory ability of the canine may exceed that of the laboratory test, it is important to use both to demonstrate a "rate of confirmation" in order to lay the proper foundation for canine testimony.

Cadaver detection

Cadaver dogs are trained to locate the scent of human decomposition. A scent cone spreads from a deceased person in the same fashion as that of a live person. However, the odor that the dog searches for in this case is a generic scent of death caused by the chemistry of decomposition [41]. The scent can also be moved by water from a gravesite causing the dog to alert some distance away

from the body. Further confounding the issue is the fact that the water that moves the scent can be above or below ground [41].

Komar [42] conducted ten blind field tests with eight canine teams that simulated actual search conditions. Recovery rates of the human remains ranged from 57% to 100%. Handler error and inexperience were identified as issues that actually lowered the success rate.

Conclusion

Although the studies cited previously come from a range of law enforcement disciplines, a number of conclusions can be made that influence the direction of future research.

First, a number of environmental factors have been identified that impact the ability of the canine as well as the nature of scent as it is perceived. Temperature, humidity, and wind were documented in numerous studies. These factors already identified open the door to criticism of existing research by demanding additional effort in their control during research. And to further confound empirical study, other factors not yet identified properly in the research may come into play. For example, if one were to study scent detection within the laboratory setting, then the scientist is able to control for a number of the environmental factors. Temperature and humidity can be maintained constant and wind can be eliminated. However, the canine is a biological instrument and, as such, can influence findings inadvertently. There is an almost endless list of factors that can influence the performance of the dog. Food consumption, sleep, exercise, and stress all have the ability to positively or negatively impact performance. When dealing with multiple dogs, this problem multiplies. In order to generate rigorous findings, extreme effort must be made to ensure that each dog's life (inside and outside of the lab) is as similar as possible. Serious canine researchers, such as Auburn University's Institute for Biological Detection Systems, actually document and control food consumption while maintaining the dog's weight between 85% to 95% of its normal weight.

Second, handler error was identified numerous times throughout the literature. The olfactory ability of the dog has little relevance if the handler cannot properly interpret the alert of the dog. Future research should require more autonomy on the part of the dog, and

off-lead exercises without the handler present may provide greater accuracy of the actual ability of each dog. Hypothetically, the canine could be given instructions through an intercom system and his progress monitored via one-way glass or video surveillance.

Third, contamination problems or issues occurred in the majority of the research. As demonstrated by the large discrepancies in the actual definitions or medium of transference, it has been difficult to control for a variable that is difficult to quantify. Therefore, it is suggested that future research identifies contamination possibilities and designs methodologies that are able to control for this volatile variable. However, since contamination is a very real factor for practitioners of canine law enforcement, rigor in the laboratory environment may not translate into usable information in the field. Therefore, it is prudent to conduct more research in the field while documenting, rather than controlling, environmental factors. Over time, sufficient data could be collected that withstands the scrutiny of academia and the judiciary, while providing valuable insight to those whose very lives may depend upon it.

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