Specialized Use of Human Scent in Criminal Investigations

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Introduction

Human-scent evidence is not new. Europeans have been using scent-discriminating canines in criminal investigations for more than 100 years. Recent discoveries and improved techniques, however, have catapulted this tool into the forefront of a number of major criminal investigations. Scent-discriminating dogs have identified the scent of bomb builders from exploded bomb remains, and drive-by shooters have been identified from scent collected off expended cartridge casings.

Using scent-discriminating dogs in criminal investigations should be limited to establishing a scent relationship between people and crime scene evidence. Because human scent is easily transferred from one person or object to another, it should not be used as primary evidence. However, when used in corroboration with other evidence, it has become a proven tool that can establish a connection to the crime.

Human Scent

Human scent has been historically defined as a biological component of decomposing dead skin cells, also known as the skin raft theory (Syrotuck 1972). Scent-dog handlers

have relied on this theory, but it has had no supporting scientific basis. Current research suggests that human odor is more complex.

Human Skin Emanation Research for Mosquito Attractiveness

Research has been conducted to determine the components of human odor that is breathed out or is deposited by the skin, not for purposes of specialized canine use, but to identify a mosquito's attraction to human odor. In a study, test subjects transferred their odor by touch onto 2 to 25 2.9mm glass beads. On this small amount of surface area, 346 discernable peaks were detected by cryofocused gas chromatograph/mass spectrometer analyses. All but 43 component peaks were classified and identified (Bernier et al. 2000).

In a study of yellow fever mosquitoes preference for lactic acid, two-choice tests with odor samples from human hands revealed statistically significant differences in the level of mosquito attraction. The differences in mosquito attractiveness between the donors were found to be consistent during the 11-month test period, thus suggesting some level of genetic predisposition to mosquito attractiveness (Steib et al. 2001).

The human odor studies for mosquito attraction show that human scent could consist of many more compounds than can be defined at this time. Not knowing exactly what the dogs are detecting, the identical and fraternal twin studies that explored genetic and dietary differences to determine the uniqueness of scent need to be explored.

Uniqueness

The issue of genetic makeup and human odor was studied using scent-discriminating canines and scent collected from three sets of twins. The test subjects included fraternal twin baby boys on the same diet, identical twin baby boys on the same diet, and identical adult twins on different diets. Dogs were able to correctly identify the fraternal baby twins on identical diets and the identical adults twins on different diets, 89 and 83.5 percent respectively. The dogs were able to correctly identify the identical twins on the same diet only 49 percent, which is no better than chance (Hepper 1994).

It was found in scent lineup tests when the scent of identical twins is offered to dogs in succession, the dogs could not differentiate between the twins. In tracking experiments in which two scents are offered simultaneously and mixed up, the dogs were able to distinguish between the two identical twins (Kalmus 1955). These studies show that dogs can differentiate between identical twins, especially when the twins are living apart. However, discrimination is more difficult when the differences were genetic (Schoon and Haak 2002A).

Blended Odors

A scent item with multiple human odors is a contaminated-scent article. The term contaminated-scent article, however, is a misleading description. Due to the resiliency of human scent, there are few evidence items that carry only one human scent. The items used for scent articles are manufactured, transported, stocked, and sold by people who, by touching them, contribute additional scents. Scent canines have the ability to work accurately with an article containing blended human odors.

European studies have demonstrated the ability of properly trained scent-discrimination dogs to accurately match a target's scent to a contaminated-scent article. These studies established the basis for use of scent identification lineups as reliable evidence in criminal proceedings. In one study using scent-identification lineup dogs, it was determined that dogs, "like other animals, are capable of discerning the odor of different individuals on an object, and can use these odors in scent identification lineups" (Kalmus 1955; Schoon and Haak 2002B).

Canine Ability to Follow Unique Human Scent

Dogs can be trained to track and follow the combined odor of crushed vegetation, soil disturbance, and a generic human-scent component. Tracking dogs are often not provided the scent of their quarry at the start. The dogs are typically not scent specific; they are trained to follow the freshest track. The limitation of this is that dogs may leave the target's track for a fresher track, thus limiting its use in urban areas.

Dogs can identify a person's odor that is blended with other human odors. Using a variation of tracking known as trailing, bloodhound handlers use dogs to differentiate a trail of specific human odor from all other odor trails in a search area. The trailing dog is trained to identify and follow the human scent presented to it by the handler. This scent is presented as a scent article containing the unique scent of a suspect or missing person. If a trail of scent matching the scent on the scent article is at that start location, the dog commences to trail and follows that trail to the exclusion of all others. If there is no matching scent trail at the start location, the dog refuses to trail.

In a study to evaluate the reliability of trained bloodhounds to identify and trail the scent of individual humans in high-traffic areas, eight bloodhounds completed five tests on 48-hour-old trails. Trails were in areas normally encountered in criminal casework—regional parks, college campuses, and urban environments. The trail layers came from different ethnic groups and ages, and trails ranged from .5 to 1.5 miles in length. Using scent pads collected with the Scent Transfer Unit-100 (STU-100), a vacuum-scent-collection device, five experienced bloodhound/handler teams had a success rate of 96 percent with no false identifications. Three novice bloodhound/handler teams had a 53 percent success rate and one false identification. False identifications are defined as an alert on a person whose scent was not present on the scent pad presented at the start of the trail (Harvey and Harvey 2003).

Case Example

On May 13, 2002, a U.S. mail carrier in Philadelphia discovered a package in a mailbox that appeared to be an improvised explosive device. The Philadelphia Police Bomb Squad responded and rendered the device safe. In a mailbox 1.5 miles away, a similar package was found the following day and rendered safe.

Two days later, human scent was collected with the STU-100 from the remains of these two packages. Starting the dog at one of the mailboxes, a positive indication for scent was given, and the dog began to trail. After two days of car and pedestrian traffic, the bloodhound was able to follow the trail into a neighborhood where the trail ended. A

second dog was started in the neighborhood and identified a house occupied by Preston Lit. The criminal investigation, conducted separately from the human-scent work, brought the police to the same location (Meserve and King 2002). Lit pleaded guilty and received a 16-month sentence in federal prison.

Scent Collection Methods

There are four commonly used methods to collect human scent for canine use.

The traditional method is to let the canine smell the article of evidence or scent source directly. Direct scenting poses the greatest risk of contaminating or destroying forensic evidence that will be collected later in the investigation.

A second method involves swiping the surface of the object with a sterile gauze pad and transferring human scent from the source to the pad. The pad is then given to the canine as the scent source or stored for later use. Although this method provides a reliable scent, swiping can remove or contaminate fingerprints, DNA, or trace evidence.

Absorption involves placing a sterile gauze pad on the surface of the source for an unspecified time. A variation of this method, which can be used on small objects, involves placing the source object and a sterile gauze pad in a plastic resealable bag. After time, the pad is offered to the canine as a scent source. This time-consuming method may introduce the possibility of contamination and destruction of evidence.

Figure 1. Scent Transfer Unit

The newest method of scent collection is the scent transfer unit (STU-100). The STU-100 (Figure 1) is a portable forensic vacuum configured for 5 X 9-inch sterile gauze pads and is being used by police agencies and the Federal Bureau of Investigation. The STU-100 uses airflow to move scent from the surface of the evidence to the gauze pad and may be

used without contacting the evidence. This airflow system provides a safe method of collecting human scent while protecting potential forensic evidence. Multiple scent pads can be easily and quickly collected from small objects, clothing, bodies, and immobile surfaces, such as windowsills.

The FBI and the Southern California Bloodhound Handlers Coalition examined the potential for the STU-100 to produce scent pads with scent transferred from an article of evidence. When standard STU-100 cleaning protocols are used (vigorous scrubbing with isopropanol swabs), tests have shown that either no scent cross-contamination occurs from one pad to the next or the contamination is below the detectable threshold of the trained canine. To validate this cleaning procedure, scent from a known contributor was collected from an object onto Pad A, and then the STU-100 was cleaned. A new sterile pad (Pad B) was placed on the machine, and the vacuum was run for the standard period, but with no object on the gauze pad. In blind tests where Pad B was offered to trained bloodhounds at the start of the known scent contributor's trail, the dogs refused to trail.

To address the issue of whether vacuuming human scent can produce a viable scent pad, the concept of how odor enters the olfactory system must be considered. The process of breathing creates a vacuum that draws odor into nasal passages where olfaction occurs. Using a forensic vacuum for collecting human scent uses the same principle. Human scent, whether particulate or gaseous in nature, is airborne and can be moved from one surface to another with or without contact. The use of a vacuum to transfer scent onto a gauze pad is no different than other forensic vacuums used to move solids and gases onto a surface or into a system for purposes of analysis.

The use of the STU-100 has been controversial in several court proceedings. A review of defense expert witness testimonies and the subsequent appellate court decisions highlight the misunderstanding of human-scent evidence (California vs. Flores 2000; California vs. Willis 2002; California vs. Willis 2004).

In one testimony, a defense expert in veterinary medicine testified, "We don't know what human scent is" (California vs. Flores 2000). Yet in a later testimony, this same expert stated the method to clean scent from the STU-100, "does not remove all of the odors reliably by any means." That he had never seen the STU-100 before the day of this testimony did not deter the expert from opining, "It's going to collect a sample that has an unknown degree of contamination" (California vs. Willis 2002). These types of unsupported opinions have cast an inaccurate and negative light on a very useful tool. The notion that a scent pad collected by any means contains only one scent is not realistic. That multiple scents on a scent article render a positive outcome useless has been scientifically proven wrong. All scent collection methods will create pads with blended odors. Because human scent is easily transferred, a positive trail or identification resulting from any scent article only shows a relationship to that article and must be verified and corroborated through other investigative means.

Scent Durability

A review of canine work in criminal investigations and training records provided anecdotal information describing the survivability of human scent on objects and in the field. The resiliency of human scent has been demonstrated on objects subjected to heat, explosions, aging, and contamination by other odors. Similarly, human scent in the field has been proven viable despite the influence of the environment and aging.

Figure 2. Two Burning Arson Devices

In March 2001 the FBI and Southern California Bloodhound Handlers Coalition conducted a joint study to determine the viability of human-scent evidence on bomb components and arson evidence. Twenty bloodhound teams of varying ages and experience participated in the study. Three dog teams had previously trained on bomb debris, and 12 teams had trained on arson debris. Four pipe bombs (black powder, smokeless powder, binary, and C4) were handled by test subjects and then detonated. Two arson devices (metal gas can, plastic gas can) were also handled by test subjects and then burned for two minutes with .5 liter of gasoline before being extinguished with water (Figure 2). Scent was collected from all items on sterile gauze pads using the STU-100.

Two weeks later, six test stations were set up at El Dorado Park in Long Beach, California. Blind trails were laid in a split-trail format so that each dog would have to indicate the presence of matching scent, trail to, and properly identify the correct person. Fresh trails were set up for each dog team tested. The overall combined score for positive-scent matches was 78.3 percent. Of those dogs that indicated a positive-scent match, 88.6 percent positively identified the correct target. There were no false-positive identifications in this study (Stockham et al. in press).

On October 21, 2001, the FBI and Southern California Bloodhound Handlers Coalition conducted a feasibility study to determine the survivability of human scent after decontaminating for biological agents. Five sheets of paper containing a separate target

odor were irradiated at SteriGenics, Tustin, California, with average doses of 40.7 kGy and 39.5 kGy for one hour. In six tests on six trails, bloodhounds with a demonstrated ability to scent discriminate indicated the presence of matching scent from the irradiated papers. All six dogs trailed to and correctly identified the target corresponding to their scent pad. The study established that human scent could survive irradiation.

In another portion of the same study, four sheets of paper were sprayed with a ten-percent solution of sodium hypochlorite to determine the survivability of scent. Four bloodhounds were tested on sheets of paper subjected to the sodium hypochlorite solution. In each test series, the bloodhounds were able to indicate the presence of matching scent. These dogs also trailed to and correctly identified their corresponding targets. These tests were conducted on single-blind trails in a regional park setting subject to contamination from animals and other humans.

Literature describes the successful yield of DNA profiles on expended cartridge casings and bullets (Szakacs 2000), so it would not be unreasonable for a scent-discriminating canine to identify a human odor from these items. Dr. Ian Findlay, Australian Genome Research Facility, University of Queensland, Australia, recently reported that they have been successful in getting "DNA fingerprints from cells decades old" (Kingsley 2002). Whether the detection limits of a canine are low enough to detect cellular material of this age and level has not yet been determined.

Human scent is susceptible to the effects of the environment. Anecdotal information suggests scent survives better in a grassy, shaded meadow than in a paved, urban parking lot. This is probably due to temperature, moisture, and quantity of vegetative matter to which scent can adhere. It is also believed that scent will not survive for long periods outside. However, recent studies and case experience indicate that human scent is more resilient than previously believed.

In May 2003 the FBI hosted a bloodhound research workshop at its Academy in Quantico, Virginia. One of the blind tests conducted during this workshop evaluated the viability of aged human scent in a heavily populated residential area after a long scent-build-up period. The test was designed to determine if targets' scent would build up at their primary residence and remain detectable after a long absence.

After living in a Stafford, Virginia, house for seven years, the test subject moved to Albuquerque, New Mexico. Six months after her departure, a bloodhound team was started at an intersection several houses away. Using scent collected from a letter mailed from the former occupant, the bloodhound indicated matching human scent, trailed to, and identified the house in question. Not incidentally, the letter used in this test was mailed from Albuquerque, New Mexico, to Stafford, Virginia, through the U.S. Postal system. Upon arriving in Virginia, the letter was irradiated at the U.S. Army Medical Research Institute of Infectious Diseases, Fort Detrick, Maryland, with Cobalt 60 at an average rate of 39.5-40.7 kGy for 59 minutes. Thus, in spite of an irradiated and heavily contaminated-scent article, and a residence unoccupied by the scent target for six months, the dog performed successfully in this blind exercise.

Case Example
In July 2002 a pipe bomb exploded inside a car in Washington, DC, and severely injured the driver, 21-year-old Wright Sigmund. Shortly after the bombing, Prescott W. Sigmund, the half-brother of the victim, disappeared. His car was found in a Metro-parking garage with a suicide note. Seventeen days after the bombing, the Bureau of Alcohol, Tobacco, Firearms, and Explosives took the FBI's Human Scent Evidence Team to the entrance of an unknown neighborhood. With no prior knowledge of the whereabouts of Prescott Sigmund's residence, a Human Scent Evidence Team dog team, using scent collected from the pipe bomb fragments, trailed to Sigmund's house and alerted on the front door.

Figure 3. Bloodhound Alerting at a Door

The team was then taken to the top level of the Vienna, Virginia Metro Station parking garage where Sigmund abandoned his car. Seventeen days after the car was abandoned, in nearly 100° F temperatures, the bloodhound immediately followed Sigmund's trail to the elevators and alerted on the elevator door (Figure 3). On the ground level, the bloodhound ignored the other commuters and trailed to a bus stop kiosk where the trail ended. A check of the subway entrance was negative. It was the opinion of the dog team handler that Sigmund caught a bus or was picked up at the kiosk. Despite the high number of commuters that used this urban Metro station during the 17-day interval, the bloodhound had no difficulty differentiating the suspect's scent from that of thousands of riders.

On November 9, 2002, *America's Most Wanted* ran a segment featuring Prescott W. Sigmund. Missing for almost four months, Sigmund turned himself in to police in Missoula, Montana. Sigmund also told the investigators that he parked his car at the Metro station and rode the bus out of town. Sigmund pleaded guilty to three felonies with an aggregate sentence of 32 years in prison. This confirmed case experience demonstrates

the durability of scent on bomb fragments as well as the survivability of scent in a heavily trafficked urban setting (Stockham 2003).

Scent Relationships

Human scent is easily transferred from one object to another so that relationships between objects and people are sometimes unknowingly established. Identifying someone's scent at a crime scene is not an indication of complicity. It simply establishes a direct or indirect relationship to the scene.

In an experiment investigating the transfer and survivability of human DNA, the problem of third-party contamination was considered. It was found that not only is the offender's DNA transferred onto the victim, but the victim's DNA is also transferred onto the offender (Rutty 2002). Partial profiles of one or more third parties were also found. According to this study, the likely source for the contamination was inanimate objects in the building handled by both people. Rutty states, "the finger pads of the offender may not only transfer offender's DNA onto the skin of their victim and vice versa but also transfers third party DNA from objects or the third party themselves, which the offender handled prior to contact with the skin of the victim." (Rutty 2002). This phenomenon is also noted in canine use.

Knowing that identifiable cellular materials can be transferred does not render the use of scent-discriminating canines impotent. The illustration provided by Rutty reinforces several issues with respect to using human scent in criminal investigations. First, knowing that cellular material can be transferred, a suspect identification made by a scent-discriminating canine only establishes that some form of relationship to the scent object exists. Second, the relationship may only be determined through an investigative process. Scent work must be verified by the investigative team.

Dog Team Proficiency

The use of human-scent-evidence canines in criminal investigations must be limited to those dogs able to demonstrate proficiency in a number of areas. The abilities of the dog-handler team must be verifiable through training records and blind-proficiency testing.

Positive and Negative Scent Checks

The dog-handler team must differentiate between a positive-scent match and a negative-scent indication. When presented with a scent pad that does not have any odor that matches scent present at the start of a trail, the dog must respond that there is no scent match and not begin a trail. This negative indication must be clearly discernible by the dog handler. The dog must also be able to work a series of negative checks in a day without a detrimental impact on the dog's performance. Because of the potential for false-positive trails, dog-handler teams unable to consistently discriminate between positive- and negative-scent matches should not be used to identify people in criminal investigations.

Aged Trails
A dog must be proficient with seven-day-old trails in rural and urban environments.

Layered Scent
Layered scent is scent of multiple ages left by one or more people in the same vicinity. Layered scent may be from the suspect or from others present at a crime scene. It is commonly associated with people living at or frequenting an area. A dog must be able to discriminate among layered scents on trails. In an area where there are multiple trails, the dog must choose the freshest trail.

Vehicle Trails
A vehicle trail is a human-scent trail from a moving vehicle. To prevent carbon monoxide poisoning, positive-ventilation systems in automobiles move fresh air through the interior of the vehicle and into the atmosphere, thus laying a scent trail. A dog must have a demonstrated ability to follow vehicle trails. In addition, the dog-handler team must be able to determine changes in modes of travel, such as from foot to vehicle.

Drop Trailing
Drop trailing is following a trail for long distances by checking for scent at intersections along the trail. Typically, the dog is scented at the intersection, and the direction of travel is established. The dog is then transported to the next intersection along the trail and the process is repeated.

Scent Articles with Blended Odors (Contaminated-Scent Articles)
Contaminated-scent articles are those that have been handled by someone other than the suspect. Scent articles may possess the smell of family members or law enforcement personnel. Knowing that a trained scent-discriminating dog will trail any of the human odors present on the collected pad, the dog-handler team must demonstrate a proficiency in the missing-member method. With all known people who handled the article present for the dog to dismiss before starting to trail, the dog is tasked to trail the missing scent. A properly trained dog will sort through the available smells and trail the missing person.

Identifications
Any dog used for casework must have a handler-verifiable method of suspect or victim identification. This identification informs the handler that the person acknowledged by the dog is a match to the scent that was presented to the dog. This identification lays no foundation for the basis of guilt or innocence; it merely indicates that through direct or indirect means, this person's odor matches the collected scent. Acceptable identifications include a sit, offering a paw, jumping on a lap, vocalization, or some other behavior that is clearly discernible to the handler.

Qualification and Certification

There are no national qualification standards for human-scent-discriminating canines. Agencies employing a dog team must ensure that the team has met appropriate casework training and preparation standards to ensure the dog's work will be admissible in court.

Thorough and well-documented training records, case records, confirmation logs, and if available, prior testimonies can be used to assess a dog team's preparedness for casework. The dog handler should provide these records to prove that the canine has performed reliably in a variety of conditions.

Agencies using human-scent-discrimination dogs should identify an appropriate certification or qualification standard that can be used to demonstrate the dog's preparedness for casework. The Southern California Bloodhound Handlers Coalition uses the following approach to qualifying dog teams:

- Weekly supervised group training
- Weekly individual training with a mentor
- Blind prequalification testing when the team is performing consistently well
- Blind qualification test
- Postqualification casework validated by experienced dog teams

Testing demonstrates a dog team's consistent results over a long-term evaluation period. Training past the certification stage must address any evolving working conditions that the dog team might face, such as new types of scent objects or smaller scent quantities on scent objects and in the field.

Proficiency Testing

Dog-handler teams should undergo an annual proficiency test. At a minimum, a blind-proficiency test should be administered to test a dog-handler team's ability to accurately discriminate between positive- and negative-scent matches. Dog-handler teams must be able to consistently indicate a negative response if placed on a trail that does not contain a match to the presented scent article. Otherwise, a positive response and the resulting trail cannot be trusted as accurate.

Breeds

All dog breeds are capable of scent discrimination. The American Kennel Club awards titles to dogs competing in tests that include the ability to successfully select a dumbbell with its handler's scent from a lineup of dumbbells.

The trained bloodhound's ability to trail and identify originated in large-game hunting. Although the bloodhound may be well suited for the variation of scent discrimination used in trailing, this ability is not limited to the breed. Labrador retrievers, German or Dutch shepherds, and Belgian Malinois are also used in police work because of their drive and response to training. Each breed has advantages or disadvantages, depending on the task.

Criminal Investigations

Dogs that can follow a scent trail reliably may provide valuable information in a criminal investigation, but if they cannot discriminate between positive- and negative-scent matches, the results must be questioned.

Location Checking

A new method has been developed to use positive- and negative-scent checks to aid investigators throughout the case. Known as location checking, canines are used to identify a scent association between a person and residences, businesses, or other areas. Investigations that have produced a list of potential suspects may use location checking to determine whether a scent relationship exists between a suspect and evidence of the crime. When a location is identified, investigators may also use the scent dog to check other locations where the same suspect is known to have been. Blind-negative controls are introduced throughout the location checking process to ensure dog teams are working accurately. Multiple dog teams, working blind to the other's results, may be used in location checking to confirm identifications. This technique has potential to focus an investigation and rule out suspects. It should be used with discretion given the potential for cross-contamination of human scent evidence and with the understanding that a scent match must be confirmed by other investigative techniques. Likewise, lack of a scent match is not a guarantee that a suspect has no association to a crime.

Station Identifications

Station identifications are a variation of location checking. Investigators may bring a suspect into a police station for questioning or in custody. The suspect is taken to a room and the route documented. A dog team is then started on the suspect's trail using scent evidence from the crime. The dog team is blind to the suspect's trail and room location. A scent match produces a trail into the building, along the route traveled by the suspect, ending with a dog identification of the suspect. A no-scent match produces a negative indication, and the dog refuses to trail. Station identifications should be performed with discretion due to building ventilation, other areas in the building the suspect may have walked, and the potential for cross-contamination with scent from investigators or crime scene personnel.

Negative Controls
Periodically throughout an investigation, blind-negative controls should be introduced to the dog-handler team. This negative control should contain a human scent that is not present at the location being checked. The inclusion of a negative control offers a measure of surety that the dog is not providing a false-positive alert. Failure to properly respond to a negative control during an investigation should preclude the dog-handler team from conducting any further work until training and blind-proficiency testing demonstrate the dog's renewed reliability to differentiate between positive and negative trails.

Positive Responses
Positive responses should be verified by at least one other canine team. Verifications should be blind. Using a second scent article is recommended. Verifications are also a measure of surety that a positive response is not a false positive.

Documentation

The level of documentation required during the use of human-scent canines is generally dictated by the agency requesting the dog team's services. Because scent pads are derivative evidence, a chain of custody must be maintained. If the scent pad is used multiple times, each usage must be documented on the chain-of-custody form. Documentation must record every person that has contact with the evidence, dog, and handler. Evidence-storage documentation must be maintained.

Conclusion

Used with discretion, the information gained from human-scent-discriminating dogs can be a valuable tool for law enforcement. The ability of these dogs to establish a connection between people and crime scene evidence has been demonstrated through scientific study, practical experience, and confirmed criminal case results.

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