

Sniffers as an Aid in Crime Investigation

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Abstract: A lot of techniques are available and are being developed in the field of forensics to aid the criminal investigations. In any criminal investigation, the one thing that holds utmost importance is the evidentiary material that can provide some information about the identity of the individual or the material in question. One of the most reliable methods of Crime scene investigation, which has been used for the last so many years and is still being used without any expostulation is taking the assistance of “Sniffers”. The sniffers have the non-pareil power to differentiate between a large variety of smells and this quality has been highly assistive in solving a number of cases. The paper highlights the basic mechanism of sniffing, the specialization of dogs over other animals in sniffing and the advancements in the form of mechanical sniffers which are the machines formulated to replace the canine and for the facilitation to present the findings in the court of law.

[Singh P, Kaur M. **Sniffers as an Aid in Crime Investigation**. *N Y Sci J* 2015;8(10):87-92]. (ISSN: 1554-0200).
<http://www.sciencepub.net/newyork>. 17

Keywords: Odorant; Vomeronasal; Stereophonically; Leptospirosis; Ambushes; Microfluidic

1. Introduction

The human mind has always been partisan to searching newer methods of manipulating nature's wonders for human benefits. One of such adopted wonders is a man's favorite animal: the dog. Though, the dogs have been used as pets for thousands of years, but in modern era dogs are used in the field of forensics as 'sniffers'. The term 'Sniffers' refers to specialized dogs trained to detect a particular substance or material using their non-pareil power to differentiate between the large varieties of smells. Almost all the mammals have the sense of smell, but dogs are superior to all of them in sniffing power [1]. Dogs, usually referred as K9s by law enforcement professionals, have played an important role in legal investigations for decades, with their keen sense of smell being noticed and utilized [1].

The vital aspect of a forensic investigation is to detect specific substances or locate specific people. This exclusive feature of dogs has been employed for the detection of drugs, explosives, wildlife scat, human remains or any other explicit material, which may prove to be of importance in any criminal investigation. Sophisticated detection equipment does exist, however, the technology can often be expensive, have unsuitable portability, and may even prove to be of no use when searching vast areas.

2. Mechanism behind sniffing

Dogs have the same basic mechanism of sniffing as that of humans, but the only difference lies in the basic structure of the nose and number of smell receptors. As the air is a mixture of a wide variety of odors, the ability of the dogs to distinguish between different overlapping odors and to trace a

material at very less concentration are the attributes that makes it suitable for detection purposes. Sense of smell comes about because of specialized nerves in the nose in a specialized area known as the olfactory bulb. Purportedly, humans are able to distinguish over 10,000 different odor molecules.

The air inhaled through the nose passes over a bony plate that contains millions of olfactory receptor neurons in an epithelial cover. These olfactory nerves have cilia extending out into a mucosal lining that is exposed to the atmosphere. The cilia contain specialized proteins that bind low molecular weight molecules (odorants) and are called olfactory receptors. Each receptor has a binding site that has a particular shape and which matches either with a specific molecule or with a group of structurally similar molecules [2].

Buck and Axel, joint recipients of the 2004 Nobel Prize in Physiology reported that approximately some 1,000 genes encode the olfactory receptors for a particular type of odorant molecule. On the interaction of the right molecule with the right receptor, the receptor changes its shape (called its structural conformation) which generates an electrical signal. The signals move to the olfactory bulb and then to the areas of the brain where one nerve impulse is interpreted as a particular smell. The recognition of odor quality and intensity in a mix of inhaled air is checked in the olfactory bulb by the olfactory receptors that produce spatial patterns of olfactory bulb activity and are characteristic for a specific odorant or a group of odorant molecules. The information is processed at higher levels of the olfactory system and in the brain to produce the

perception of smell. A diagrammatic representation of the whole process is given in Fig-1.

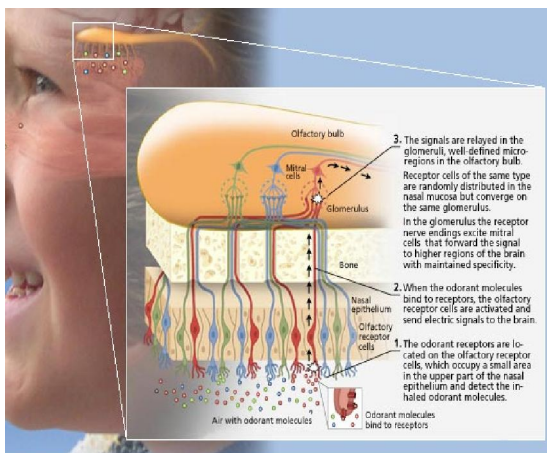


Figure 1. Diagrammatic representation of smelling mechanism in humans [2]

Though, the basic mechanism of smelling in dogs is same as that of humans, but the dogs have a much higher potential in differentiating various smells because of the following reasons:

2.1. The surface area of olfactory epithelium in humans is approximately 1 inch square while that in dogs is about 30 inch square. This allows the dogs to analyze a larger volume of air in a unit time.

2.2. The number of odorant receptors is about 6 million in humans and approximately 250 million in dogs. This huge difference in the number of odorant receptors indicates the dogs' ability to sniff and detect.

2.3. The olfactory lobe is larger in size in dogs. This allows inhalation of comparatively large amount of air, which in turn facilitates a better analysis.

2.4. The vomeronasal organ, a sensory organ that detects pheromones and other chemicals in dogs, is non-functional in humans. Though chemical communication does appear to occur among humans, but this does not necessarily implicate the functioning of vomeronasal organ.

2.5. The morphology of the nose also plays an important role in sniffing efficiency. A dog's nose is engineered in a way to ensure maximum efficiency. The nostrils have side slits and the air is exhaled through these side slits so that it does not dilute the scent of inhaled air. The manner in which exhaled air swirls out actually helps usher new odors into the dog's nose. This also allows the dog to sniff just about continuously.

2.6. A dog's wet nose also helps it smell more acutely, as odorants are captured as they dissolve in the moisture.

2.7. Dogs smell stereophonically, that is, they can determine the direction of the odorant molecules depending on the nostril which detects the odor.

A striking outcome of all of these adaptations is that dogs can smell certain substances at concentrations up to 100 million (1×10^8) times lower than humans can. A tabular representation of the number of scent receptors in humans and various dog breeds is given in **Table-1** and a diagrammatic representation of the olfactory system of a dog is given in **Fig-2**

Table 1. No. of receptor cells in human and various dog breeds.

Species	Number of Scent Receptors (millions)
Humans	6
Dachshund	125
Fox Terrier	147
Beagle	225
German shepherd	225
Bloodhound	300

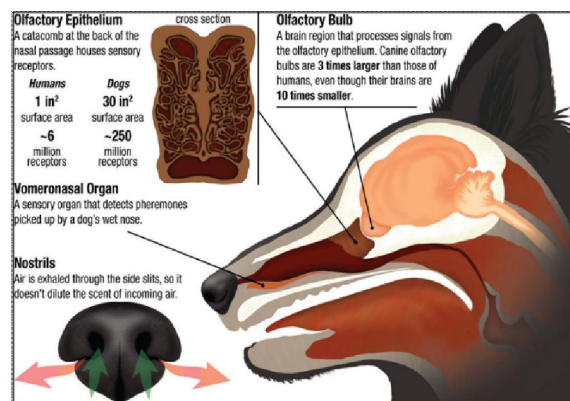


Figure 2. Representation of the olfactory system in a dog[3]

3. Training the Sniffers

Before starting the training, the most important thing is to select a dog most suitable for the purpose. The selection is made on the basis of physical, temperamental and behavioral standards.

3.1 Physical Standards

The dog should be-

3.1.1. Free of distemper, infectious canine hepatitis, leptospirosis, mange, heart worms, rabies, ectoparasite infestation and other health conditions deemed unacceptable by the veterinarian.

3.1.2. No greater than Grade I hip dysplasia either judged clinically or by X-rays.

3.1.3. Standard immunization series against disease completed.

3.1.4. Fully grown.

3.2 Temperamental and Behavioral Standards

3.2.1. Evidence of inquisitiveness with a desire to explore the environment.

3.2.2. Neither aggressive nor shy of people.

3.2.3. Highly responsive and friendly to people.

The usual manual used by experts to train the sniffer dogs comprises of following six steps [5]-

Step 1

In this step, the dog is made to focus on the ball to the exclusion of everything else around him. A toy or a rolled towel may also be used for this purpose depending upon the response of the dog to the material.

Step 2

In this step, the dog is taught to play fetch with the trainer (giving him a chance to get the ball and bring it back). A leash may be required initially, but once the idea that bringing the ball back leads to more play is clear, he is ready for the next step.

Step 3

Here, the same ball with which the dog was trained earlier is stored in a box or bag and the dog is commanded to find it. The training is started with one specific scent and different scents can be incorporated once the habit is developed. For best results, a small amount of the actual substance is also placed with the ball in the box or bag.

Step 4

Once the dog learns to find the ball, he is taught signals to indicate the same. The signals may be sitting down at the site, lying down, scratching the ball, or barking depending on the dog's personality, but sitting is the most commonly used signal. After every successful hunt the dog is rewarded by letting play him with the ball, offering food or petting.

Step 5

Over time, the ball is discarded and replaced with the matter of interest the dog is being trained to find, using the command "Search" each time to signal him to start looking for the ball or the matter of interest. When he locates the desired object and sits to signal his find, the dog is rewarded as his treat for a successful find.

Step 6

In the last step, the trainer starts moving from making the drugs very obvious to making them harder for the dog to find. The dog is always

rewarded and praised for a successful find, since this is what he works for and it is his only reward.

4. Sniffers as an aid in Forensic Investigations

The most commonly used dog breeds for forensic investigation include Belgian Malinois, Bloodhound, Doberman, Pinscher, Dutch Shepherd, German Shepherd Dog, Pit Bull, Australian Shepherd, Beagle, Basset Hound, English Cocker Spaniel, English Springer Spaniel, Foxhound, Golden Retriever, Labrador Retriever, Sulimov Dog, Schnauzer, Weimaraner Beagle, Coonhound, etc. because of their abilities to discern a variety of overlapping odors. In addition to this major breed of sniffers, some detection dogs have also been trained to search for particular objects. Based on the purpose they are being used for, sniffers have been categorized as follows:

Public-order enforcement dogs

These dogs have the job of chasing a fleeing suspect and detaining the suspect until officers arrive; or restraining suspects from some action by threat of the dog being released and causing harm. This is the traditional image of a police dog.

Illicit-substance detection dogs

These dogs assist their handlers in airports and other transport hubs, sniffing the passengers from a distance to detect any illegal substance a person may be carrying with themselves or in luggage or carry-on items. The substances in question are usually drugs and explosives, although many nations also interdict foreign food items.

Drug Detection Dogs

The police commonly train canines to detect the presence of illicit substances in the tiniest amount. Such dogs are frequently trailed through train stations, airports, country borders, workplaces, and even schools to allow police to locate individuals who are carrying these illegal substances. The dog may be moved near pieces of luggage, near groups of people, and generally kept in the vicinity to react if he picks up on an odor of interest. An average stop and search conducted by officers may yield nothing, especially if the subject has hidden the drugs somewhere on his person. However properly trained canines are usually able to detect the scent of illegal narcotics, regardless of where and how the suspect has concealed them.

Explosives Detection Dogs

Perhaps used more in recent years due to the increased attention to terrorism, canines have also been trained in the detection of explosive materials. The dogs are trained to detect the odors of specific substances such as sulphur, nitroglycerin, and any other compound commonly used in the production of gunpowder and explosive devices. Such specially trained dogs may be used in airports to detect or at

least deter terrorism, or in the homes of suspected bomb-makers to identify the presence of these substances on work surfaces and in storage areas. In these scenarios, it is particularly vital that the canine is trained not to touch any substances or devices it does locate, as many types of bomb can potentially explode if touched.

Arson dogs

Similar to canines trained to detect explosives, arson dogs are instructed to detect the chemical traces of accelerants. During an arson investigation, one of the primary tasks is to determine what caused the fire and, if accelerants were used, establish where the accelerant was placed. Though the odor of most forms of accelerant is generally quite strong, a fire scene will often be engulfed in the smell of smoke and various burning materials. However, dogs can be trained to pick out the specific orders of flammable substances and locate the source. Even if the accelerant is found in numerous locations, the dog is trained to pinpoint the area in which the accelerant concentration is at its greatest.

Cadaver dogs

Also known as ‘decomp dogs’ these specially trained canines are trained to follow the scent of decomposing flesh in order to locate the bodies of deceased human beings. Whether the cadaver is on the surface, buried underground or underwater, a dog’s nose is powerful enough to pick up the scent and trace it back to its source. Cadaver dogs can not only locate actual human remains, but also the location in which a corpse or body parts may have previously been stored by tracking down residual scents. Depending on the use of the cadaver dog, they will be trained to detect specific decomposition odors. For example, some may be trained to detect odors associated with the early stages of decomposition, whereas others may be required to locate the older remains. Some dogs are specifically trained to detect dead bodies underwater, with the canine situated on a shoreline or boat. A newer concept is that of historical human remain detection dogs, which are trained to locate historical or archaeological graves.

Search & rescue dogs

Like cadaver dogs, search and rescue canines are trained to specifically locate human beings. However, in this instance, they are searching for living individuals, usually missing people, individuals lost in the wilderness, and those trapped during mass disasters. For example, trained dogs will be used in the case of an earthquake, where numerous people may be trapped inside demolished buildings. The dogs follow the scent of each person, so that they may be located and finally rescued.

Tracking dogs

Tracking dogs are trained for the same purpose as search and rescue dogs – they track down and locate living human beings. However, in this case the dogs are trained and used to track down fugitives or suspected criminals. The scene of a recent crime may hold the scent of the perpetrator which, if investigators work quickly enough, may be tracked by a trained dog. Alternatively an object or a piece of clothing known to have belonged to or been touched by the suspect may be presented to the dog, hopefully allowing him or her to follow the scent and locate the suspect.

A dog can detect many other things, both animate and inanimate, including the following-

❖ **DVDs**

Dogs can be taught to detect the material polycarbonate, a key component of all DVD disks. They can thereby help to bust the massive DVD counterfeiting trade. Indeed, on their first raid, two dogs found a pile of pirated DVDs worth over \$3 million. The success of this single raid managed to annoy the Malaysian DVD pirates so much that they offered a \$30,000 bounty for the deaths of the dogs.

❖ **Drowned Bodies**

Water search dogs are often used by police in the USA to locate and recover drowned corpses. The scent of drowned bodied is released into the water currents, which then end up being released into the air. The dogs which work either from the shore, from a boat, or even while swimming in the water—track this scent to its strongest point, the body itself.

❖ **Ambushes and Vietcong Equipment**

During the Vietnam War, the US military used scout dogs to detect enemy soldiers. The dogs were also able to detect tunnels, weapons, and booby traps—saving hundreds of US soldiers’ lives in the process. Since barking would give away their position, the dogs were taught alternative ways of showing that danger might be afoot. Some learned to raise the hair on their necks; others crossed their ears, and at least one dog would walk on its hind legs when it smelled something sinister.

❖ **Minerals and Ores**

The government in Finland financed a program that taught dogs to detect valuable sulphide-containing rocks. When the rocks break apart, they release a smell not unlike rotting eggs, which the dogs can track easily so easily that during one hunts a dog found a deposit of “great economic significance.”

Some other cases where the sniffing ability of the dog can be employed for identification are-

- ❖ Identifying Endangered animal species (e.g., black-footed ferret, bumblebee nests)
- ❖ Invasive species (e.g., quagga mussel)
- ❖ Currency

- ❖ Mobile phones (as contraband in prisons)
- ❖ Mold
- ❖ Plants, animals products and other agricultural items
- ❖ Polycarbonate optical discs such as DVDs (used to search for bootleg recordings)
- ❖ Termites
- ❖ Wildlife scat
- ❖ Whale Poop
- ❖ Ovulation in Cows
- ❖ Cancer
- ❖ Diabetes
- ❖ Bacteria

5. Biological alternatives to canines

Canines aren't the only creatures with olfactory systems many times more sensitive than humans that we can tap for help. The list is ever growing, but Honeybee, Fruit Fly, Giant African Pouched Rat, Mouse are some unexpected "sniffers" that can perceive scents undetectable by humans—such as the VOCs (volatile organic compounds) associated with diseases, drugs, landmines, explosives etc.

Though the sniffers have an un-matchable power of scent differentiation, but dogs as well as the above mentioned sniffers are after all, animals only and not a machine that would work as programmed. Therefore, to increase the level of reliability and to have authentic evidence that could be easily justified and accepted by the court of law, the scientists have devised a machine programmed to mimic the function performed by a dog's nose.

6. The mechanical sniffer

Inspired by the biology of canine scent receptors, scientists have developed a chip capable of quickly identifying trace amounts of vapor molecules [6]. It is a portable, accurate, and highly sensitive device that can sniff out vapors from explosives and other substances. Researchers have also designed a detector that uses microfluidic nanotechnology to mimic the biological mechanism behind canine scent receptors. The device is both highly sensitive to trace amounts of certain vapor molecules, and is able to tell a specific substance apart from similar molecules. This device can detect airborne molecules of a chemical called 2,4-dinitrotoluene, the primary vapor emanating from TNT-based explosives. The human nose cannot detect such minute amounts of a substance, but "sniffer" dogs have long been used to track these types of molecules. Their technology is inspired by the biological design and the micro scale size of the canine olfactory mucus layer, which absorbs and then concentrates airborne molecules.

The technology has been patented and exclusively licensed to **SpectraFluidics**, a company that Piorek co-founded in 2008 by private investors.

The technology combines free-surface microfluidics and surface-enhanced Raman spectroscopy (SERS) to capture and identify molecules. A microscale channel of liquid absorbs and concentrates the molecules by up to six orders of magnitude. Once the vapor molecules are absorbed into the microchannel, they interact with nanoparticles that amplify their spectral signature when excited by laser light. A computer database of spectral signatures identifies the kind of molecule so captured.

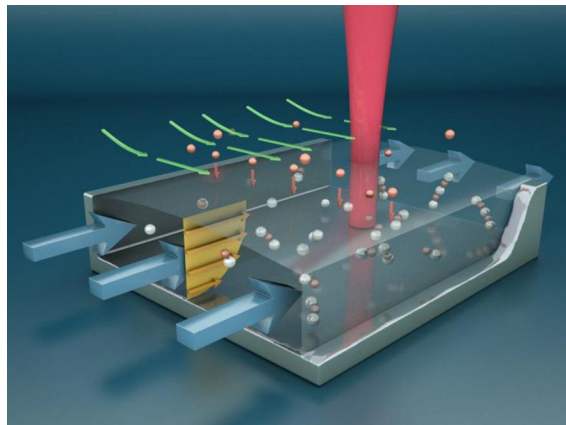


Figure 3. Showing diagrammatic representation of the structure of the mechanical dog device [6]

The device consists of two parts, there's a microchannel, which is like a tiny river that is used to trap the molecules and direct them to the other section, where a mini spectrometer powered by a laser that detects them. These microchannels are twenty times smaller than the thickness of a human hair.

The technology could be used to detect a wide variety of molecules. The applications could extend to certain disease diagnosis or narcotics detection. Such detectors can detect molecules from someone's breath (as in case of breath analyzers) that may indicate disease.

7. Conclusion

Sniffer dogs have been used traditionally in forensic investigations for many years and the dogs have proved their fate by successfully detecting and locating the desired objects almost in every case. The un-matchable power of sniffing has selectively and effectively made the dogs superior to every other creature that exists on this earth and has justified their employment for investigation purposes. Some of the non-conventional sniffers like Honeybee, Fruit Fly, Giant African Pouched Rat, and Mouse have been used to check the level of accuracy of detection and further techniques are being developed to facilitate

the use of these non-conventional sniffers commonly. Researchers have also developed a machine known as 'the mechanical sniffer' that mimics the functioning of a sniffer dog and is much more reliable and accurate in detection. Easy handling, reliability and accuracy of this machine are the key features that project it as the future aspect of sniffers in the field of forensic investigation.

Acknowledgements:

The authors are thankful to all the sources for providing the required information in formulating this manuscript.

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10/23/2015

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