

USE OF DETECTION DOGS IN FORENSIC INVESTIGATIONS: THE ITALIAN SCENARIO

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Abstract: This paper describes the latest advancements of forensic odorology, a technique that uses canine units to detect forensic evidence at a crime scene. For a long time, dogs' olfaction has been used to find missing persons, dead bodies, and explosive substances. These dog skills have been further de-veloped to identify olfactory fingerprints at crime scenes. Currently, forensic odorology plays an important role in pyromania and arson investigations, computer and electronic material searches, fugitive location, currency, tobacco and weapon recovery, as well as poaching fighting. During the Scent Detection activity, the dog is trained to detect the smell of a previously imprinted substance (substance odor imprinting). When the dog sniffs traces of a specific substance, it focuses on the track and follows it to identify the odor source. Thus, the dog will reproduce a previously ac-quired behavioral response to signal the handler the presence of the substance. In this review, we touch upon canine forensic odorology, highlight the most innovative forensic activities carried out with dogs, and discuss how these investigative tools can be used in criminal trials.

Keywords: odorology, crime scene investigation, detection dogs.

INTRODUCTION

The dog's nose possesses about 300 million olfactory receptors, as compared to about 6 million in the human's nose. Consequently, the olfactory cortex occupies 12.5% of the total canine brain mass, while in the human brain it barely represents the 1% [1]. Forensic odorology is an important tool to collect and store olfactory traces in order to confirm the presence of a person or substance at a crime scene. Forensic odorology relies on the existence of unique individual human odorotypes, and on the dog's ability to discriminate and differentiate people olfactory fingerprints, supported by expert technical assessments [2]. Forensic odorology was developed in Germany in the 1940s and was later exported to the former Soviet bloc countries [2]. Dogs are trained to recognize odors with high efficiency [3]. The olfactory inspection and odor identification constitute key moments for the collection of valid

odorology evidence and for its subsequent use in a trial. All operations are recorded by using audio-video devices. The assessment is performed by comparing and matching the olfactory trace with that of one or more suspects [4]. It is essential that the intervention of the ca-nine (K-9) unit is timely as the crime scene can be easily contaminated. The odorological assessment consists of three phases [2]: 1) detection of the olfactory impression; 2) odor conservation; 3) comparison of the olfactory trace with the scent from other people. The human scent is a complex mixture of compounds with different chemical properties and concentrations. Scents are usually classified into primary, secondary, and tertiary categories [5]. The primary scent category includes genetically conditioned compounds. Their relative concentrations remain constant over time regardless of environmental factors, diet, weather conditions, air humidity, visceral state, emotional state, illness, menstrual cycle phase, medications, etc. In

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the secondary category are found skin-derived scent compounds, which depend on internal and external factors. Tertiary scents derive from the environment (scents of a workplace, cosmetics, cigarette smoke, gasoline, scents of other people or domestic animals) [6]. In favorable environmental conditions, a dog is able to identify odors left up to six weeks before, especially in the early evening as the ground temperature is slightly higher than the air temperature and odors evaporate more easily [7]. Adverse weather conditions hamper dog's work, eventually leading to the cancellation of odorous traces. Wind, rain, humidity, solar radiations are factors that can impair scent detection [8]. Nevertheless, a recent study by Filetti *et al.* reported that dogs were able to identify the person who touched an object at the crime scene. The dog training procedure showed excellent sensitivity (between 99.48 and 100%) and specificity (between 60 and 100%), having a positive predictive value (PPV) ranging between 97.94 and 100% and a negative predictive value (NPV) ranging between 85.71 and 100% [9].

Specialized dog units

Man-trailing dogs

Man-trailing dogs are used in crime prevention, rescue operations, and investigation activities to identify and track the path taken by a subject. Man-trailing is a K-9 discipline using specially trained dogs to identify a track and follow its trail. These dogs are trained to scent discrimination by following the molecules dispersed in the environment; dogs search for a person's scent in buildings, woods, or crowded areas. This technique also finds an important use in the civil protection sector and in forensic investigations. An olfactory input, which can be any object, garment, or setting (i.e. the passenger compartment of a vehicle) impregnated with the scent of the person to be located, is presented to the man-trailing dog, who will be asked to follow that specific olfactory trace. The timelier is the intervention, the higher are the chances to achieve a successful search [10].

Cadaver dogs and human-remains detection dogs

Human remains detection dogs (HRDDs) are "canines specially trained to find human decomposition scent and alert their handler to its location" [11] Cadaver dogs are routinely used in police operations and are considered specialty units among the Police Forces in the EU. [12]. Cadaver dogs do not target the scent of a specific subject, rather they are trained to detect the scent of decomposing human remains. Cadaver

dogs can locate whole bodies (including buried and submerged bodies), decomposed bodies, and body parts (such as blood, tissues, hair, bones, and skeletal remains) [13]. Dog units can work off-lead to search for buried remains on large areas, or on-lead to retrieve clues from a crime scene [14]. Remarkably, cadaver dogs can operate in water to locate submerged bodies. They seat perched at the bow of a boat, scan the environment while the boat slowly moves along a predetermined grid, and bark when they intercept target molecules on the water surface [13]. This will restrict the search area and facilitate Police divers recovery operations.

Drug, weapon and explosive detection dogs

Through Scent Detection training, specialized dog units manage to detect narcotic drugs and psychotropic substances such as marijuana, hashish, cocaine, heroin, LSD, methamphetamine, ecstasy, even if hidden within or mixed with other substances of vegetable origin such as coffee, sugar, etc. [15, 16]. The list of illicit substances used to train dogs must be regularly updated since new drugs are continuously released on the market. Special K-9 units trained to search for weapons, detonating devices, and explosives are employed to contrast common and organized crimes, as well as subversive actions and terrorist attacks. Dogs are trained to recognize 20 different types of explosive substances [17]. The dog and the handler support the Explosive Ordnance Recognition (EOR) team which deals with the search and identification of bombs. Subsequently, the Explosive Ordnance Disposal (EOD) team, or the Improvised Explosive Device Disposal (IEDD) team - the bomb disposal squads - intervene to dispose of the explosives [18]. In Italy, detection dog units often patrol harbors, airports, and railway stations. In Southern Italy and main islands, special K-9 units are integrated in the Carabinieri Heliborne Squadrons named "Cacciatori" (Hunters) [19]. These units mainly operate in territories with high crime rates, where geography and topology provide criminal organizations with natural hiding places to store illegal weapons and explosives used in crimes against the property (robberies, valuable armored track assaults, cash ATM blasting, bomb attacks for ransom, etc.), against the person (kidnappings for ransom), or against the State (assault to State representatives, subversive or terrorism acts involving explosives, etc.). These special dog units, are trained and prepared to - quickly disembark helicopters and land in inaccessible, woody and rocky territories. They have the task to patrol these areas to find depots, caves, farmhouses, bunkers built in dense vegetation that can be used as hiding places

for weapons and, in some cases, a fugitive hideouts. Finally, and especially in international scenarios such as Iraq, Afghanistan, Kosovo, and Bosnia, dog units are used for the detection of Improvised Explosive Devices (IED) as well as of anti-personnel and anti-tank mines [19]. Some devices are only detectable by dogs because the explosive is contained in wooden or plastic boxes and the electrical ignition is made of graphite [20 - 22]. IED uses ammonium nitrate as explosive, which has a devastating explosive power. This substance is easily detected by dogs [22]. In Italy, the Canine Training Squadron of the Military Veterinary Center (Ce. Mi. Vet.) trains dog units for explosive detection, search, immobilization of hostile personnel, as well as for the patrolling and remediation of strategic objectives [23].

Electronic Storage Detection Dogs

Dogs trained to sniff electronic equipment are the least known specialization of canine training, which has been implemented after the 9/11 terrorist attacks. International Police Forces begun to train search dogs for the retrieval of electronic equipment such as USB sticks, micro SIM cards, mobile phones, DVDs, CD-ROMs, external hard drives, and memory cards. Specialized dog units in this sector are called Electronic Storage Detection Dogs (ESDD) [24]. The ESDD dog is trained to sniff out the chemical component, triphenylphosphine oxide (TPPO), common to most electronic gadgets and storage devices, as a thermal insulator [25]. The “porn-sniffing dog” is able to intercept the chemical components characteristic of the storage units containing child pornography [26]. In Italy, since 2016, an agreement among the Ministry of Justice, the Department of Prison Administration and the Italian Kennel Club (Ente Nazionale Cinofilia Italiana, ENCI) promoted the use, within detention centers, of specialized dog units for the detection of narcotics, mobile phones and hidden SIM cards [27].

Cash detection dogs and anti-smuggling dogs

K-9 units are also used to contrast financial crimes such as tax evasion and money laundering. These units, named Cash Detecting Dogs (CDD), are mainly composed of male Labrador Retrievers which are trained to sniff and identify hidden money. CDD trainings focuses on the olfactory detection of molecules contained in the ink used for banknote printing. In Italy, CDD units are trained by the K-9 group of the Guardia di Finanza (a law enforcement agency under the authority of the Ministry of Economy and Finance) using residues of shredded banknotes provided by the Central Bank of Italy. Skilled CDDs can identify and discriminate among different types of banknotes

[28]. Guardia di Finanza K-9 groups also train dogs to recognize the scents of manufactured tobacco products. Anti-smuggling dogs are fundamental in contrasting cigarette contraband, the illicit trade of counterfeited tobacco products, as well as the smuggling of salt, coffee and other goods [28].

Anti-poison, anti-poaching and apprehension dogs

Poison detection dogs are specialized in the identification of toxic substances, alone or in association with palatable substances (poisoned food), as well as of food contaminated with harmful objects or hazardous components (meatballs filled with nails, glass shards, or dead animal remains). These dogs are employed to contrast environmental crimes and wildlife trafficking. Dogs can smell poisons, weapons, ammunitions, laces, or traps, and they signal the handler by pointing their muzzles in the direction of the olfactory input [29]. Patrol/Apprehension K-9 units are trained to track and force offenders into submission. These units are deployed in Police decisive interventions such as the release of hostages on planes, trains and buses. In Italy, Apprehension dogs of the Carabinieri Special Intervention Group (GIS) must pass a tough selection for balance, resistance and ability to face the danger, as they must be able to withstand and operate under negative pressures such as explosions, firefights, rope descents, landing without harness during helicopter operations etc. [30].

Accelerant detection canine (arson dogs)

The arson dogs project was born in 1993 in the United States of America with the aim of contrasting the arsons and fire frauds in real estate and insurance markets. In Italy, the use of arson dogs was recently introduced, and special K-9 units of the Fire Brigade have been created for this purpose [31]. An arson dog is trained to sniff out traces of accelerants and flammable materials used to start fires such as gas, naphtha, butane, kerosene, etc. Arson dogs can be employed to search vehicles used for the transport of accelerant materials and to identify arsonists in a crowd. In fact, arson dogs can smell flammable substances on a suspect's clothing and compare them with the traces found on the fire site; in fieldwork, arson dogs search large areas around the fire site, for either physical or chemical traces left by the arsonist [10]. A wide range of dog breeds can be used as accelerant detection dogs, although Labrador Retrievers are the most commonly used. Their training lasts at least three months and includes learning how to alert the handler to the presence of flammable and accelerating materials. Evidence found by arson dogs

during fire investigations usually undergo laboratory examinations for the necessary technical-legal comparisons [32].

Admission of evidence obtained by dog units at trials: the Italian scenario

The Italian criminal trial is based on equal confrontation of the parties before an independent judge, in observance of the principles of orality and immediacy. Evidence presentation to the judge occurs during the preliminary hearing according to the articles 496-515 of the Code of Criminal Procedure. The Italian Criminal Code (Article 348), allows the judicial police to search for people who can report information relevant for the reconstruction of the events, but also to search for objects and traces related to the offence, as well as to preserve evidence and the condition of the crime scene. The judicial police shall carry out the activities specifically delegated to them by the Prosecutor (art. 370 of the Italian Criminal Code) who, with the communication of the crime report, will coordinate the entire investigative activity [33]. During the delegation phase, the Public Prosecutor can request the use of dog units according to the investigative needs. The dog units support the work of investigators; their results are cross-checked and compared with other evidence such as cellular network and mobile phone records reports, telephone or environmental wiretap transcripts, witness statements, items found at the crime scene or at other locations connected to the case. Dogs olfactory sensitivity represents a unique tool supporting traditional investigative methods. The scientific evidence can be admitted in criminal trial proceedings in the context of the judicial simulation (Articles 218-219, Italian Code of Criminal Procedure), as an expert evidence (Articles 220 et seq., Italian Code of Criminal Procedure), or through the technical assessment of evidence in the preliminary investigation phase [34]. The Italian Supreme Court of Cassation (Criminal Court, Sect. IV, verdict n. 43786, 17 September 2010) determined the criteria to establish whether a methodology constitutes a reliable tool providing scientific knowledge. This also applies to evidence gathering with K-9 units. The Supreme Court only admit evidence obtained through a scientific methodology that is reliable, reproducible, and widely accepted by the scientific community [35].

Search for missing people

The use of specialized dog units is envisaged in cases of missing persons. In these contexts, it is required tight coordination among Prefectures, Police Forces, and Judiciary, in cooperation with local and national bodies, voluntary associations (i.e. Red Cross), Civil

Protection-affiliated search and rescue K-9 centers [36]. To become operational, search and rescue dog handlers must obtain an official certification issued by the Italian Kennel Club (ENCI). The certificate is obtained by attending a two-year long training course and passing a final examination at the presence of Italian Kennel Club technicians. The general guidelines for search and rescue operations are issued at the national level and are supported by specific intervention protocols established at the regional level. These protocols have particular importance since dog units can support operation beyond national borders, laying the foundations for international cooperation of K-9 activities.

In conclusion, inspired by the professional experience of one of authors of this review, we analyzed the use of dogs in the forensic scenario under different circumstances: criminal investigations, preventive actions, search and rescue operations. Other dog uses in the judiciary system, such as “courtroom dogs” who assist fragile crime victims during court deposition, have not yet been explored in Italy but are common in the USA [37]. Dogs can be also used in pet therapy. Recent studies are focused on their ability to detect pathological conditions such as cancers, diabetes, seizures, narcolepsy and migraine [38], as well as in case of a global health emergency such as the current COVID-19 pandemic [39]. For this reason, it is important to highlight that science can offer fundamental contribution to the K-9 field, in particular in forensic odorology where scientific evidence provided by dogs, further supported by traditional investigation techniques, can contribute to the successful outcome of a criminal proceeding. The Italian Criminal Procedure Code and other regulatory references allow Police Forces and Judiciary to use dogs for olfactory investigations and crime scene analyses. The Judge will then assess the expertise of the K-9 operator who is called to provide his technical knowledge during the trial and according to Riezzo *et al.*, as general rule each dog’s ability and reliability are required to be shown on a scientific, well-proven, repeatable basis [40].

Conflict of interest

The authors declare that they have no conflict of interest.

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