

October 25, 2010

SCENT IDENTIFICATION IN CRIMINAL INVESTIGATIONS AND PROSECUTIONS: NEW PROTOCOL DESIGNS IMPROVE FORENSIC RELIABILITY

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SCENT IDENTIFICATION IN CRIMINAL INVESTIGATIONS AND PROSECUTIONS: New Protocol Designs Improve Forensic Reliability

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Abstract. Scent lineups are a powerful tool in the investigation of crimes. With proper procedures, both forensic and judicial, scent lineups can be valuable evidence for a jury to consider. Unfortunately, many courts have been willing to admit poorly conducted procedures, even if giving lip service to the fact that the scent lineup was deficient by saying that its admission was harmless error. The tendency of some courts to view scent lineups as an extension of scent tracking has resulted in admission of scent lineup evidence under inappropriate standards. Tracking cases have set foundational requirements from long-held social and judicial assumptions about the accuracy of dogs. Although no specific set of training procedures or testing protocols need be imposed for the conduct of scent lineups, protocols with elements that have produced highly reliable results should be developed by law enforcement authorities and insisted upon by courts. The authors believe that scent lineups under such protocols can now satisfy the *Daubert* standard for admissibility of scientific evidence, though perhaps not the *Frye* standard (because of the lack of general acceptance in the scientific community). Because the possibility of a false identification cannot be completely eliminated, corroboration by other evidence should be required, probably at a clear and convincing level.

I. INTRODUCTION

II. SCENT DISCRIMINATION IN U.S. COURTS

LINEUPS IN POLICE DOG WORK

IDENTIFICATION IN TRACKING AND TRAILING

STATION IDENTIFICATIONS

BEGINNING OF FORMAL SCENT IDENTIFICATION LINEUPS

FOUNDATIONAL REQUIREMENTS FOR TRACKING AND SCENT IDENTIFICATION

SCENT LINEUPS OF PEOPLE

SCENT MATCHES

THE CORROBORATION REQUIREMENT

JURY INSTRUCTIONS

III. SCENT IDENTIFICATION RESEARCH

CANINE PROCESSING OF SCENT INFORMATION

HUMAN ODOR

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COLLECTING SCENT
IV. TRAINING SCENT IDENTIFICATION DOGS AND PROTOCOLS FOR SCENT IDENTIFICATIONS
DUTCH TRAINING AND PROTOCOLS
TRAINING PROCEDURES IN POLAND
USE OF DUTCH METHODS BY THE FBI
INDUSTRY GUIDELINES
SUCCESS RATES OF SCENT LINEUP PROCEDURES
V. JUDICIAL STANDARDS FOR ADMISSIBILITY OF SCIENTIFIC EVIDENCE AND PERSPECTIVES ON SCENT LINEUPS
DAUBERT AND CANINE CASES
FRYE AND CANINE CASES
FOREIGN JUDICIAL PERSPECTIVES ON SCENT LINEUPS
VI. CONCLUSION
Article Bibliography

I. INTRODUCTION

Scent lineups have been used in European countries since the beginning of the 20th century and are a common part of police practice in the Netherlands, Poland, Germany, Russia, and other Eastern European Countries. In the United States, scent lineups as formal procedures have been used by some law enforcement agencies for forty years, though the rigor of European procedures developed in the last decades may be confined to the Federal Bureau of Investigation. U.S. courts have largely seen scent lineups as an extension of tracking cases, and lineups probably began in the U.S. from station identifications occurring after a tracking dog's field assignment was completed. More recently, U.S. courts have begun to recognize that scent lineups require a different set of canine skills than those required for tracking and trailing.²

In tracking, a dog is following disturbances to the ground surface, crushed vegetation, a person's body odor, and/or sweat that has gone through the person's shoes.³ In trailing, a dog is thought to be following the odor of volatile substances that flow off human skin every minute containing organic compounds and bacteria, leaving a trail often described as a plume.⁴ Although dogs in modern scent lineups may be "scented to"

² Courts seldom distinguish tracking and trailing, particularly from a legal perspective. See *California v. Sanders*, 2009 WL 3682460 (Ct. App. 2009) ("Officer Miller testified that dog 'tracking' and 'trailing' are slightly different skills and that Obe was trained to trail (but not track) scents. The relevant cases, as well as the parties on appeal, refer to dog-*tracking* evidence, but there is no suggestion that the relevant legal principles are not applicable to both tracking and trailing.").

³ See the extensive discussion by Gerritsen and Haak (2003), 31-43.

⁴ Syrotuck argued that human skin flakes create the raft that dogs follow. Syrotuck (1972), pp. 45-52. Others disagree with Syrotuck's raft theory. See Gerritsen and Haak (2001), p. 39. Courts sometimes still presume that a tracking dog is following a "skin flake" plume. See *North Carolina v. Cross*, 681 S.E.2d 566, 2009 WL 2177766 (Ct. App. 2009) ("The testimony of one canine handler indicated that the tracking dog could follow the scent of a person based on "riffs," or dead skin cells put off during high adrenaline situations."). One California court that explored the difference between tracking and trailing cited the testimony of an expert, Dr. Lawrence J. Myers, a professor at the College of Veterinary Medicine at Auburn University, to the effect that the distinction between tracking and trailing dogs may be artificial since they both detect and identify. *California v. Salcido*, GA052057, 11 (Los Angeles Super. Ct. 2005).

an item from a crime scene in the same way as tracking and trailing dogs are scented before they begin following a path, scent identification dogs do not follow footsteps or a plume, but rather are presented with (usually) five to seven objects that individuals including a suspect have handled and must choose the object that has a similar scent on it, or some of the same components to the scent, as an item taken from the crime scene.

It is the opinion of the authors that scent lineups are a significant forensic and evidentiary tool that should not be dismissed as “junk science.”⁵ That said, with the resources available to many U.S. law enforcement agencies, lineups should remain at best part of the investigative process as the procedures presently being used cannot assure sufficiently low error rates for a positive identification to be admitted as evidence in a criminal prosecution. In order for the error rates to be made low enough for admissibility in court, a number of procedures must be implemented. For instance, at least two dogs (ideally three) would have to pass control trials, including zero trials in which no alert would be correct, trials would have to be conducted with the handler and everyone in the handler’s vision blind to which stations contained scent from suspects, controls, and decoys, decoy samples would have to take into account characteristics of the subject and would have to be prepared in a narrow time frame when samples were acquired from the suspect, and so forth. No single set of protocols need be specified but procedures developed in the Netherlands and Poland, described below, provide appropriate models that with sufficient care can assure that a positive identification of a suspect has a sufficiently high probability of being accurate to make this evidence comparable to visual lineups by eyewitnesses and a number of commonly admissible forensic techniques.

As will be discussed below in the review of success rates under various procedures, it must be understood that to obtain assurances that a positive identification is highly likely to be correct, there will be a concomitant increase in the likelihood that a failure to alert may be incorrect. In other words, the precautions that reduce the number of false alerts to a level where an alert is highly likely to be an identification of the perpetrator of a crime also reduce the number of alerts overall, meaning that some perpetrators will not be identified by the dogs in such controlled scent lineups.⁶ This is, however, consistent with the emphasis of American law on preferring that the guilty should be set free rather than the innocent should be convicted.

The procedures that would make scent lineup evidence admissible are sufficiently rare in the U.S. that the FBI, as already noted, may be the one of the few agencies with facilities adequate to produce such evidence. Many state and local police departments are struggling against budget cuts and can only afford one or two canine teams, and the dogs must be generalists, trained to apprehend fleeing suspects and detect narcotics, and perhaps to fulfill other police dog functions.⁷ Some law enforcement agencies depend on

⁵ See Dog Scent Lineups: A Junk Science Injustice, report of the Innocence Project of Texas (September 21, 2009) (posted at <http://ipoftexas.org/wordpress/wp-content/uploads/2009/09/Dog-Scent-Lineups-Texas.pdf>) (stating that three men convicted in part by one handler’s testimony have been exonerated); Scent Lineups and Unvalidated Science, *Innocence Blog* (June 30, 2009).

⁶ Thus, for instance, if only two dogs qualify for final trials and only one of those dogs clearly alerts to the sample from the suspect, while the other “shows interest” but does not alert, the lineup would be deemed inconclusive and the evidence of the lineup should not be admitted. If three dogs were required (as can be the case as used in some procedures), a failure of all three to alert would exclude the evidence.

⁷ See *U.S. v. Lambert*, 834 F.Supp. 1318 (D. Kan. 1993) (“multi-purpose dog” certified in obedience, agility, narcotics detection, explosives detection, cadaver detection, article search, area search, tracking,

independent contractors, but few of these have dedicated scent identification dogs. Few handlers have received the level of training that might assure that their results could withstand a rigorous scrutiny by the experts in this area and perhaps none have facilities adequate to conduct rigorous testing.

After this Introduction, Part II of this article provides a history of scent discrimination in the U.S. legal system. Part II also describes the foundational requirements applied to the admission of lineups, which have often been adapted from requirements for the admission of tracking evidence. Finally, this Part describes the corroboration requirement which was common in tracking cases and often applied in scent identification cases.

Part III describes research indicating that dogs have the olfactory acuity to distinguish individual human scents, the chemical composition of human scent, procedures by which scents are isolated and preserved for use in scent lineups, indications that scents of certain individuals may be attractive to a dog and thereby result in false alerts, and other scientific issues relevant to the study of scent identification.

Part IV describes the training of scent identification dogs in the Netherlands, Poland, and the U.S., as well as protocols for the conduct of lineups in the Netherlands and standards that have been recommended for the conduct of scent lineups in the U.S.

Part V describes studies on the success rates of scent lineup procedures, particularly looking at studies using protocols developed in the Netherlands and Poland. This Part also compares success rates of dog scent lineups to other forensic procedures including visual lineups conducted for eyewitnesses. This Part discusses the judicial standards for the admission of scientific evidence and how these standards have been applied to scent lineups in federal and state courts.

II. SCENT DISCRIMINATION IN U.S. COURTS

Scent identification procedures, particularly scent lineups, differ from narcotics or explosives detection work in that the dog must match an odor on an item believed to have been touched by the perpetrator at a crime scene to an item touched by a suspect in that crime, such as a metal tube in a row of tubes, the rest of which have been touched by other individuals having nothing to do with the crime. The items not touched by the suspect are called foils. Either that, or particularly in older cases, the dog matched the odor on the crime scene item to a row of individuals, one of whom was the suspect. This is closer to the traditional sight lineup used for witnesses and victims of a crime. Variations of both these approaches can be found in U.S. cases.

building search, and aggression control); *Byrom v. Mississippi*, 863 So.2d 836 (2003) (dog trained in narcotics, tracking, and apprehension); *Tariq-Madyun v. Alabama*, 2010 WL 2160290 (Ct. Crim. App. 2010) (handler described his canine partner as a “dual purpose canine” that worked as a narcotics detector but also worked as a tracker and performed building searches, area searches, and article searches; dog led to shirt which was found to contain DNA of suspect). Some functions merge in specific cases. See *Illinois v. Griffin*, 48 Ill.App.2d 148, 198 N.E.2d 115 (Ct. App. 1964) (dog released to apprehend suspect in building followed scent to suspect); *Michigan v. Laidlaw*, 169 Mich.App. 84, 425 N.W.2d 738 (Ct. App. 1988) (dog following location scent was put in car after suspect was sighted and taken to that location, where he caught up with suspect; handler interpreted dog’s “signs” as indicating he had found the source of the scent he had previously been following); *Illinois v. Holmes*, 397 Ill.App.3d 737, 922 N.E.2d 1179 (Ct. App. 2010) (dog brought to do article search finds drugs; dog was trained in both tracking and narcotics detection).

In narcotics and explosives detection work, on the other hand, the dog is trained to recognize the odors of a group of drugs, explosives, or both. The dog is deployed in various environments to find out if a vehicle, a suitcase, a mail package, currency, or some other item carries the scent of a drug or explosive the dog has been trained to recognize. The dog is usually trained to recognize a fairly limited set of odors, and regularly refreshed and tested as to recognition of those specific odors. A scent identification dog must be able to match a scent he has never smelled before the day of a test against a choice of scents that he has also not smelled before.⁸

LINEUPS IN POLICE DOG WORK

Lineups of various sorts have been common in police work, and police dog work, for a long time. Suspect lineups for visual identification by a victim or witness are well known from both fact and fiction. In police dog work, lineups have been used with narcotics detection dogs sniffing a row of packages,⁹ luggage,¹⁰ and envelopes containing currency (where one of the envelopes contained cash taken from a suspected drug dealer).¹¹

Cadaver dogs have been used in lineups of vehicles, one of which was suspected of being used to transport a body.¹² In a California case involving a cadaver dog, a court imposed foundational requirements similar to those of basic tracking dog law—that the dog is trained, experienced, and proven reliable, that the lineup was properly and fairly conducted, and that the scent on the vehicle had not become stale. The tendency of courts to apply tracking dog requirements to non-tracking situations will be discussed with regard to scent lineups.¹³

Of course, narcotics and explosives detection dogs working at border checkpoints, airports, and other locations, could be described as doing a sort of continual lineup work since they are being asked to identify a scent in a location containing a large number of objects that potentially could hold that scent.

IDENTIFICATION IN TRACKING AND TRAILING

Tracking dogs are often observed to bay at the party they have been tracking when they find him, and generally stop tracking because they have found what they were looking for. Such cases have long been analyzed by courts under a common law of tracking

⁸ Scent identification has not always involved human odor. Scent identification dogs were used to identify individual Amur tigers in one study. Kerley and Salkina (2006).

⁹ U.S. v. Lyons, 957 F.2d 615 (8th Cir. 1992) (suspicious package put in room with other packages; dog only alerted to suspicious package). See also Colorado v. Boylan, 854 P.2d 807 (1993); Ohio v. Knight, 82 Ohio Misc.2d 79, 679 N.E.2d 758, 759-760 (Ct. Com. Pleas 1997).

¹⁰ U.S. v. Bronstein, 521 F.2d 459 (2nd Cir. 1975) (dog sniffed 50 pieces of luggage on a conveyer belt); U.S. v. Ferguson, 935 F.2d 1518 (7th Cir. 1991) (two separate dogs alerted to suspect's luggage in lineup with three non-suspicious bags at DEA office in Union Station, Chicago).

¹¹ Hetmeyer v. Virginia, 19 Va.App. 103, 448 S.E.2d 894 (Ct. App. 1994). The appellate court cited a tracking case, Epperly v. Virginia, 224 Va. 214, 294 S.E.2d 882 (1982), for designating the handler as an expert.

¹² New York v. Shulman, 6 N.Y.3d 1, 843 N.E.2d 125, 809 N.Y.S.2d 485 (2005); California v. Rodrick, 2001 WL 1422348 (Ct. App. 2001) (delay in bringing matter to trial partly due to conduct of “cadaver scent lineup,” a procedure not otherwise described).

¹³ Connecticut v. King, 2004 WL 2012943 (Ct. App. 2004). For cadaver dogs, the staleness requirement makes little sense since cadaver dogs are often able to recognize cadaver scent years after the body was present at a location.

developed by courts beginning in the late nineteenth and early twentieth centuries. In a 1979 Vermont case, for instance, a bloodhound was set on the trail of men who had been drilling a hole into a pharmacy. The dog tracked to a location where the handler saw only some scrap metal and he tried to pull the dog away from the area, thinking she had lost the scent.

Thinking that West Virginia Red was mistaken, Winter [the handler] tried to drag her back onto the course which she had originally pursued. But the dog was not to be deterred. She continued to pull him directly into the tall grass, so he again searched the area. This second sally disclosed a man lying face down in the grass. He was dark-haired, bearded, and clothed in denim pants and a blue work-shirt.

Police officers handcuffed the suspect and, as he was standing between them, West Virginia Red went up to him and placed her paws on his chest, indicating that she had found the person for whom she was searching.¹⁴

Naturally the behavior of the suspect on being found was itself of evidentiary value. Finding a suspect hiding after tracking is probably part of why many tracking cases do not raise particularly strong arguments against the implicit identification.¹⁵

A 1921 case from West Virginia involved removing the defendant from the house to which the bloodhounds had tracked in an attempt to verify that the dogs had been tracking the suspect and not someone else in the house where he was found.

The bloodhounds were taken to the point from which the shot seemed to have come, and there they took up the trail and followed it for a distance of about eight miles, to the home of Luke McKinney, the father of the accused.... Having led the crowd to the front door of the home of Luke McKinney, the dogs were taken behind the house and kept there until London McKinney was aroused and taken from his bed and to a point 75 or 100 yards from the house. Then they were again put upon his trail, and went to him and gave manifestations of their identity of him as the person they had been trailing. Thereupon he admitted he had been at the house of J. G. McKinney on the previous evening, at about 7 o'clock or 7:30, and also that he had fired the shot.¹⁶

A 1989 Georgia case involved bloodhounds that were brought to the scene of a burglary. The suspects had been arrested by the time the bloodhounds arrived, however, and when the door of the patrol car was opened, the dogs alerted to one of the suspects.¹⁷

¹⁴ Vermont v. Bourassa, 137 Vt. 62, 65, 399 A.2d 507, 510 (1979).

¹⁵ See McCray v. Florida, 915 So.2d 239 (Ct. App. 2005).

¹⁶ West Virginia v. McKinney, 88 W.Va. 400, 106 S.E. 894, 895 (1921). The National Police Bloodhound Association emphasizes the value of trailing the scent of a suspect in later alerting to that suspect. Doug Lowry, NPBA President, telephone conversation (February 15, 2010).

¹⁷ O'Quinn v. Georgia, 153 Ga.App. 467, 265 S.E.2d 824 (Ct. App. 1980), citing the test for admissibility set forth in Aiken v. Georgia, 16 Ga.App. 848, 86 S.E. 1076 (Ct. App. 1915) (case reversed because person other than handler testified concerning actions of dogs, and for other errors); see also McDuffie v. Minnesota, 482 N.W.2d 234 (Ct. App. 1992) (dogs alert to suspect in car); Colorado v. Brooks, 975 P.2d 1105, 81 A.L.R.5th 779 (1999) (dog alerted to suspect in handcuffs standing among police officers, began nuzzling and pawing him, which handler said was alert to person dog had been tracking). See also South

A case from 1987 involved burglars who were seen entering an appliance store. The police were called and interrupted the burglary but the men were able to get into a Chrysler and flee. After finding the Chrysler abandoned, an officer saw footprints in the snow leading to a wooded area.

Approximately forty-five minutes later, the bloodhound team arrived and assumed control at the scene. Officer John Seighman of the Greensburg Fire Department scented his bloodhound, “Jake,” on the front seat of the Chrysler automobile. Jake then began to follow one of the three sets of footprints leading into the woods. When the footprints disappeared, Jake continued into the woods, through a group of thickly clustered pine trees, and back onto Route 31.

In the meantime, Officer McElfresh, who had remained at the abandoned car, observed an individual, later identified as Michaux, walking toward him on Route 31. McElfresh approached Michaux and, after observing that he had pine needles in his hair and weeds protruding from his collar, took him into custody. Shortly thereafter, Officer Seighman and his dog arrived back at the scene of the abandoned vehicle. They approached in the same direction from which Michaux had come. Jake sniffed several of the people present, but stopped when he came to Michaux and nosed him “like a vacuum cleaner.” Seighman interpreted this to mean that Jake had found the person whose scent he had been following.

The court found corroboration of the bloodhound evidence from the pine needles in the defendant’s hair, the weeds protruding from his collar, the fact no one else was on the roadway where he was apprehended, and the fact the defendant had been close to the vehicle seen speeding away from the burglary.¹⁸

Some cases have combined tracking or trailing at one stage of the investigation and a scent lineup at another stage.¹⁹

STATION IDENTIFICATIONS

Sometimes lineups in the U.S. have been conducted near the scene of the crime or near the terminal point to which a dog has tracked.²⁰ Many cases also describe dogs alerting to suspects they have previously been tracking,²¹ often in police stations. In a 1917

Carolina v. Brown, 103 S.C. 437, 88 S.E. 21 (1916) (dogs alerted to individuals in crowd at location of fire, but dogs were not brought to scene until 15 hours after fire began, which court held not in the period of their reliability); *California v. DeSantiago*, 2003 WL 21753766 (Ct. App. 2003) (dog brought to neighborhood where car used in liquor store robbery and murder was abandoned and trailed to houses of various relatives and a girlfriend of suspects, and one dog alerted to suspect while he was being interviewed by a detective; court remanded for scientific validity of scent transfer unit used to create scent pads to scent the dogs).

¹⁸ *Pennsylvania v. Michaux*, 360 Pa.Super 452, 456, 520 A.2d 1177, 1178 (Super. Ct. 1987).

¹⁹ This is common in station identifications, but situations have occurred where the trailing followed a lineup. See *Arizona v. Roscoe*, 145 Ariz. 212, 700 P.2d 1312 (1984), where subsequent to vehicle lineup, the dog was taken to the area where the victim’s bicycle was found and scented to clothing of the suspect. The dog’s alert was arguably to its identification of a trail. There were other lineups in the case.

²⁰ *Buchanek v. City of Victoria*, 2009 WL 500564 (S.D.Tex. 2009), 2009 WL 1268069 (S.D. Tex. 2010).

²¹ See *U.S. v. Cofield*, 254 Fed.Appx. 971, 2007 WL 3083542 (4th Cir. 2007) (tracking dog sniffed gun near flight path of perpetrator and followed path to police car where defendant was under arrest); *California v. Sanders*, 2009 WL 3682460 (Ct. App. 2009) (trailing dog scented to paper towel that wiped steering

Arkansas case, dogs tracked to the suspect's house and even to a drawer where spent cartridges similar to those used in the attempted murder were found, and to a bed under which was found the possible murder weapon. The dogs were then taken to the police station and went to the defendant in the office where he was being held.²² In a 1936 Mississippi case, dogs picked up the trail of a suspect outside the county courthouse and followed it to the cell where the suspect had been placed after his arrest on other evidence.²³

This kind of identification is sometimes still found,²⁴ and is sometimes called a station identification, as described by three authors, one from the FBI:

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.²⁵

In a 1971 North Dakota case, a dog's actions in helping find the murderer are described by the North Dakota Supreme Court where testimony indicated:

Rye was given a scent from a pillowcase in Carol's apartment; that Rye twice followed a trail that ended in the alley outside Carol's apartment; that she and Rye, along with the pillowcase, were taken to the Grand Forks Police Department, where Rye was once again given a scent from the pillowcase; that he then followed a trail into and through the police station to the place where Iverson was seated; and that he then smelled Iverson and wagged his tail and looked toward her, which is the sign that Rye had identified the source of the scent found on the pillowcase.²⁶

wheel led to batting glove, later alerted to car in which suspect was sitting; court rejected defense argument that paper towel may have been contaminated because officer did not know if anyone else may have touched it).

²² Cranford v. Arkansas, 130 Ark. 101, 197 S.W. 19 (1917).

²³ Hinton v. Mississippi, 175 Miss. 308, 166 So. 762 (1936).

²⁴ New York v. Gangler, 227 A.D.2d 946, 643 N.Y.S.2d 839 (Ct. App. 1996) (dog scented on victim's car alerted to defendant in sheriff's office; use of dog in this manner was not a search under the Fourth Amendment).

²⁵ Stockham et al. (2004).

²⁶ North Dakota v. Iverson, 187 N.W.2d 1, 20 (1971); see also California v. Salcido, GA052057 (Super. Ct. 2005) (dog alerted to suspect in room with two other individuals); California v. Willis, 115 Cal.App.4th 379, 9 Cal.Rptr. 3d 235 (Ct. App. 2004) (dog showed interest in locations where suspects were thought to have been but did not alert; later put her head on suspect's lap in police station, which was considered an ambiguous alert; appellate court found admission of the canine evidence clear error, in part because of doubts about scent transfer unit, but affirmed, deeming error harmless).

The court was satisfied that a proper foundation was laid for the evidence “notwithstanding that the bloodhound was put on the trail 24 to 48 hours after the victims had been murdered.” This is actually a tracking case where the dog was scented on a path the officers knew the suspect had walked when going into the police station.

A 2004 California case resulted in alerts to three separate individuals apparently involved in a crime, and also involved tracking from the scene of the crime. An individual got out of a car and shot several people, murdering one. Officers arrived a few minutes later and found an expended bullet and 19 nine-millimeter shell casings. A dog was scented to the casings, and to the driver’s and passenger’s seats. The dog tracked to a house and the inhabitants were arrested and taken to a police station. What happened at the police station is then described by the court:

After the suspects arrived at the police station, Hamm [the handler] used two bloodhounds, Scarlet and Knight, to perform three identifications. First, Hamm provided Scarlet the scent taken from the Corolla's passenger seat. Scarlet began at an alley near the police station and led Hamm to an interview room inside the police station, where she identified Trigueros. Hamm then gave Knight the scent taken from one of the shell casings. Knight began at the alley near the police station, went to an interview room in the police station, and identified Trigueros. Finally, Hamm gave Scarlet the scent taken from the Corolla's driver's seat. Scarlet began at a parking structure near the police station and led Hamm to an interview room inside the station, where she identified Chavez.²⁷

The court acknowledged that defense counsel should perhaps have objected to the scent transfer unit evidence (used to extract scent from the shell casings) as not being scientifically validated, but concluded that the mass of other evidence was such that the lack of such an objection meant that the defendant had not suffered prejudice and confirmed the conviction.

Defendants have sometimes sought to introduce evidence of station identifications where the dog identified someone besides a defendant, making the alert exonerating.²⁸

BEGINNING OF FORMAL SCENT IDENTIFICATION LINEUPS

²⁷ California v. Chavez, 2004 WL 1173075 (Ct. App. 2004); see also California v. Sandoval, 2002 WL 519848 (Ct. App. 2002) (dog scented to scent pads created with scent transfer unit from seats of car used in street gang murder tracked to cells of three suspects in police station, thereby arguably identifying where each suspect sat in the vehicle); California v. Alonzo, 2008 WL 2248628 (Ct. App. 2008) (dog scented on pad with scent of shell casings followed path suspect had previously taken in police station to room where suspect was seated and put his head on suspect’s lap, not the dog’s usual alert (perhaps explained by dog’s age); California v. Demirdjian, 2003 WL 1963204 (Ct. App. 2003), Demirdjian v. Sullivan, 2009 WL 2767673 (C.D.Cal. 2009) (habeas) (dog tracked from crime scene to house of defendant’s parents, and next day identified defendant in interview room when there were about 30 people in the police station; a scent matching was conducted later by a different team).

²⁸ California v. Robinson, 2004 WL 2418068 (Ct. App. 2004) (dog did not alert to suspect who was in patrol car but later alerted to that suspect’s cell in police station; evidence not admitted because of lack of proper foundation regarding scent transfer unit used to prepare scenting items for the dog); California v. Melara, 2006 WL 164989 (Ct. App. 2006) (dog alerted to suspect not charged; handler was not “professional scientist” who could qualify admission of evidence based on creating scent pads with scent transfer unit).

Scent identification has some similarity to tracking and trailing, but in those activities the animal follows the path an individual took going to or from a crime scene, the path itself continually reinforcing the odor the dog began with.²⁹ This may lead to identification of a suspect if the dog actually comes to the individual it has been following and alerts to that individual, but quite often the trail will end at the door of a building the suspect went into, or at a place on a road where the suspect entered a vehicle and drove away. In scent identifications, the dog is in a confined area, a room or an open space, and deals only in scents, not generally in tracks left on a surface (except in station identifications and perhaps in live lineups).

It was not in the U.S. that scent lineups were first severed from tracking as separate procedures, but in Europe. Procedures with elements of the modern scent identification lineup began to be used in the Netherlands and Germany in the early 1900s. The first formal scent lineup, according to a Dutch police officer, may date from 1903:

The first person to demonstrate suspect discrimination in practical police work was inspector Bussenius from Braunschweig, Germany, in 1903. At the time, he was a policeman/dog handler working with his dog Hurras von der Polizei on a murder case. He worked with pebbles—six people were asked to hold pebbles in their hand. One of the six was Duwe von Hagenhof, who was suspected of murdering a maid. The six people were asked to put their stones on the ground. The dog was given the knife found at the scene to smell, then searched and picked out the stone held by Duwe. He confessed after that.³⁰

Stones were used in an early experiment on scent identification. Six people standing near each other threw stones onto a gravel surface. A dog was allowed to smell one of their hands and directed to find that person's stone. The dog brought back the correct stone.³¹

An early case from Holland concerned a court official who began to receive anonymous letters from someone who must have hated him. The police told him to collect objects from neighbors and other suspects. A German shepherd trained in tracking was brought to the town and smelled the obscene letter before being set loose to sniff the objects that had been collected. The dog retrieved a hat belonging to a neighbor of the court official. She was convicted, despite continuing denials of involvement.³² An unusual case from the Netherlands involved distinguishing manure from different locations, connecting manure from the barn where the crime was committed to manure found on the shoe of one of the perpetrators.³³

²⁹ Curran et al. (2010) (dogs trailing from detonation sites of car bombs and improvised explosive devices in simulations near Phoenix followed correct trails of targets 94.3% of the time, but identified targets correctly in only 82.2% of the time); see also Honhon (1967) (distance dog tracks increases accuracy when trail splits between target and two decoys; when trail splits at 50 meters, dogs followed correct trail 45% of time; when trail splits after 800 meters, dogs followed correct trail between 75% and 85% of the time).

³⁰ Kaldenbach (1998), 89.

³¹ Buytendijk (1936), 97-98.

³² Schoon and Haak (2002), p. 20. For the early history of scent identification, see also Schoon and Massop (1995).

³³ Schoon and Haak (2002), p. 27.

Scent lineups began to be a police procedure in the U.S. in the 1970s.³⁴

FOUNDATIONAL REQUIREMENTS FOR TRACKING AND SCENT IDENTIFICATION

Tracking and trailing cases sometimes demonstrate an interest in the science behind the ability of dogs to follow a scent,³⁵ but courts have not required that handlers be scientists for their testimony about the tracking of their dogs to be admitted.

Garner could not explain the scientific principles underlying Ranger's ability, opining only that it must be “God-given instinct.” Garner, however, was not required to establish the scientific basis of a trailing dog's ability to follow scent in order for his opinion to be admitted. His testimony proved that Ranger was “sufficiently trained,” that Garner “was qualified to work with the dog and to interpret its responses,” and that the responses had proved reliable in numerous other cases. This empirical evidence was sufficient to establish the reliability and, therefore, the admissibility of Garner's opinion.³⁶

A 1893 Alabama court, in praising dogs for helping to solve a murder, said: “It is common knowledge that dogs may be trained to follow the tracks of a human being with considerable certainty and accuracy.”³⁷

Tracking and trailing evidence has usually been admitted after an inquiry as to—

whether the dog is of a breed characterized by acute power of scent;³⁸ whether the dog has been trained to follow a track by scent;³⁹ whether the dog was found by

³⁴ The first cases specifically conducted as lineups date from the early 1980s. See *Epperly v. Virginia*, 224 Va. 214, 294 S.E.2d 882 (1982). Scent lineups in Poland began to be used in investigations in the 1960s. Jezierski (personal communication).

³⁵ *Pennsylvania v. Hoffman*, 52 Pa.Super. 272, 1912 WL 4825 (Super. Ct. 1912).

³⁶ *Pelletier v. Virginia*, 42 Va.App. 406, 421, 592 S.E.2d 382, 389 (Ct. App. 2004). For a further discussion of Virginia law on tracking, see *Hetmeyer v. Virginia*, 19 Va.App. 103, 448 S.E.2d 894 (Ct. App. 1994).

³⁷ *Hodge v. Alabama*, 98 Ala. 10, 13 So. 385 (1893). See also *Hargrove v. Alabama*, 147 Ala. 97, 41 So. 972 (1906); *Orr v. Alabama*, 236 Ala. 462, 183 So. 445 (1938) (dogs traced from site of slaying to defendant). See *Arizona v. Roscoe*, 145 Ariz. 212, 700 P.2d 1312, 1319-1320 (1985) for the “common knowledge” argument in a scent lineup case (“[I]t is common knowledge that some dogs, when properly trained and handled, can discriminate between human odors.”).

³⁸ The breed requirement is not generally emphasized any more, but can still be found. See *North Carolina v. Hawley*, 54 N.C.App. 293, 283 S.E.2d 387 (Ct. App. 1981) (cross between a bloodhound and a coonhound said to have 90% success rate in tracking humans, was scented to flip-flop thrown off by perpetrator and tracked to trailer park where suspects were found); *North Carolina v. Porter*, 303 N.C. 680, 281 S.E.2d 377 (1981) (finding purebred requirement satisfied “if the dog’s owner or handler identifies the dog as a bloodhound and the dog justifies this description by his performance.”). Even some older cases found pedigree largely irrelevant. See *Fisher v. Mississippi*, 150 Miss. 206, 116 So. 746 (1928) (“Counsel [objecting to the introduction of tracking evidence] have cited no authority which holds that a written pedigree is necessary, and we know of no statute making it competent or exclusive evidence.”). The more recent trend is to ignore any breed requirement completely. *California v. Craig*, 86 Cal.App.3d 905, 150 Cal.Rptr. 676 (Ct. App. 1978). (“We simply cannot say all dogs can trail a human, or even that all dogs of specific breeds can do so.”); *Vermont v. Bourassa*, 137 Vt. 62, 399 A.2d 507 (1979) (“A pedigree must be shown in many jurisdictions, but the most recent cases have not stressed pedigree as a prerequisite for the admission of trailing evidence, reasoning in essence that a dog's reliability lies in performance, not papers....”).

experience to be reliable in pursuing human tracks;⁴⁰ whether the dog was placed on the trail where the person being tracked was known to have been;⁴¹ and whether the tracking efforts took place within a reasonable time,⁴² given the abilities of the animal....⁴³

A 1997 New York case that involved dog tracking concluded that no scientific principle or procedure was at issue regarding a dog's work which was described as "an investigative rather than a scientific procedure." All that was required for admission of the tracking evidence was a proper foundation.⁴⁴

Courts have sometimes required scientific support for some elements of the foundation, such as whether a scent would be likely to be detected by the dog given the length of time since a trail was laid that a dog followed it.⁴⁵

Foundational Requirements in Scent Lineups

A discussion of the adequacy of scent lineups under standards established for the admissibility of scientific evidence under *Frye*⁴⁶ and *Daubert*⁴⁷ and related cases will be undertaken after a later section of this article discussing recent research on the reliability of scent lineups under protocols developed in the Netherlands and Poland. Neither *Frye* nor *Daubert* requirements have generally been applied in scent lineup cases, which have often accepted or adapted the foundational requirements of tracking and trailing cases.⁴⁸ Thus, one Texas found tracking and scent lineups to be similar:

For purposes of judging the reliability of evidence based on a dog's ability to distinguish between scents, we believe there is little distinction between a scent

³⁹ Generally courts have accepted the testimony of handlers as to the training a dog has received. See *Montana v. Storm*, 125 Mont. 346, 238 P.2d 1161 (1951); *Iowa v. Grba*, 196 Iowa 241, 194 N.W. 250 (1923) (though determining that tracking evidence would not be admitted in Iowa).

⁴⁰ Handlers have generally been able to establish their dogs' experience. *Michigan v. Perryman*, 89 Mich.App. 516, 280 NW2d 579 (Ct. App. 1979) (to handler's knowledge, "Schultz had never made a mistake"); *New York v. Whitlock*, 36 N.Y.Crim.R. 524, 183 A.D. 482, 171 N.Y.S. 109 (App. Div. 1918); *Mitchell v. Georgia*, 202 Ga. 247, 42 S.E.2d 767 (1947).

⁴¹ See, e.g., *Fife v. Georgia*, 16 Ga.App. 22, 84 S.E. 485 (1915). See *Kelly v. Kentucky*, 259 Ky. 770, 83 S.W.2d 489 (Ct. App. 1935) (dogs track from spot where shotgun was fired); *Scott v. Mississippi*, 108 Miss. 464, 66 So.973 (1915) (nothing in record showed bloodhounds were put on scent from scene of the crime).

⁴² See *New Hampshire v. Maya*, 126 N.H. 590, 493 A.2d 1139 (1985) (dog brought at least an hour after crime); *Iowa v. Grba*, 196 Iowa 241, 194 N.W. 250 (1923) (handler testified dog would follow trail up to 40 hours old); *Kansas v. Adams*, 85 Kan. 435, 116 P. 608 (1911) (dog followed trail 15 to 18 hours after crime; suspect when apprehended confessed); *Oregon v. Harris*, 25 Or.App. 71, 547 P.2d 1394 (Ct. App. 1976) (tracking 45 hours after crime). One authority on trailing wrote trailing dogs could often follow trails up to 16 hours old. Syrotuck (2002), 67-9.

⁴³ *Colorado v. Brooks*, 975 P.2d 1105, 81 A.L.R.5th 779 (1999).

⁴⁴ *New York v. Roraback*, 242 A.D.2d 400, 662 N.Y.S.2d 327 (App. Div.1997) (defendant had argued for *Frye* hearing, but court noted U.S. Supreme Court in *Daubert* had replaced general acceptance test with test based on Federal Rules of Evidence).

⁴⁵ See, e.g., *California v. Gutierrez*, 2004 WL 723161 (Ct. App. 2004).

⁴⁶ *Frye v. U.S.*, 54 App.D.C. 46, 293 F. 1013 (Ct. App. 1923).

⁴⁷ *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579, 113 S.Ct. 2786, 125 L.Ed.2d 469 (1993).

⁴⁸ See, e.g., *U.S. v. Gates*, 680 F.2d 1117 (6th Cir. 1982); *U.S. v. McNiece*, 558 F.Supp. 612, 12 Fed.R.Evid.Serv. 1870 (E.D.N.Y. 1983).

lineup and a situation where a dog is required to track an individual's scent over an area traversed by multiple persons.... Accordingly, we conclude that the use of scent lineups is a legitimate field of expertise.⁴⁹

This similarity justified allowing scent lineup evidence under similar requirements to those for tracking. Dogs have often been expected to function both as trackers and as identifiers for scent lineups. One handler in a Texas case testified that only after a dog demonstrated consistency in running trails was it taught to do lineups.⁵⁰

As with tracking cases, handlers have too often been able to qualify the competence of themselves and their dogs in scent lineups, and as with tracking cases, courts, and even opposing counsel, have also too often been reluctant to question such assurances by a handler. A Texas court dismissed an objection that a dog was medicated at the time of a scent lineup, noting that there was no evidence this affected her performance, rather than requiring evidence that the medication did not affect performance.⁵¹ As will be discussed below, more recent cases considering scent identification procedures have been inclined to recognize that a distinction should be made between tracking and identification, and that different foundational requirements should apply.⁵² For instance, in a 2004 California case involving a dog picking out a suspect from among five police officers, the court felt that more was required than the traditional tracking elements.

The prosecution cannot rely solely on anecdotes regarding the dog's capabilities. Instead, a foundation must be laid from academic or scientific sources regarding (a) how long scent remains on an object or at a location; (b) whether every person has a scent that is so unique that it provides an accurate basis for scent identification, such that it can be analogized to human DNA; (c) whether a particular breed of dog is characterized by acute powers of scent and discrimination; and (d) the adequacy of the certification procedures for scent identifications.⁵³

⁴⁹ *Winston v. Texas*, 78 S.W.3d 522, 527 (Ct. App. 2002) (concluding, at 527-8, that a dog is qualified if “it (1) is of a breed characterized by acuteness of scent and power of discrimination, (2) has been trained to discriminate between human beings by their scent, (3) has been found by experience to be reliable, (4) was given a scent known to be that of the alleged participant of the crime, and (5) was given the scent within the period of its efficiency.”). See also *Risher v. Texas*, 227 S.W.3d 133 (Ct. App. 2006) (adopting *Winson* factors and discussing reliability in particular).

⁵⁰ *Robinson v. Texas* 2009 WL 5205361 (Ct. App. 2009).

⁵¹ *Martinez v. Texas*, 2006 WL 3720136 (Ct. App. 2006); *Risher v. Texas*, 227 S.W.3d 133 (Ct. App. 2006).

⁵² See the discussion of *California v. Mitchell*, 110 Cal.App.4th 772, 2 Cal.Rptr.3d 49 (Ct. App. 2003) in the section on handlers as experts below, where the court noted that “a greater foundation” than the basic tracking foundation should be required for a scent lineup, and additional scientific expertise beyond that of a typical handler is necessary to establish the basis for assumptions about the degradation and contamination of scent, as well as “the uniqueness of each person’s odor, beyond the mere experiences of one trainer and one dog.”

⁵³ *California v. Willis*, 115 Cal.App.4th 379, 386, 9 Cal.Rptr. 3d 235, 241 (Ct. App. 2004).

A great deal of foundational testimony, both in tracking and scent lineup cases, could be described as anecdotal. The court did not reverse, however, finding other evidence so overwhelming that another jury would not likely reach a different verdict.

Scent lineup cases relying on traditional tracking foundational requirements have sometimes insisted on aspects of those requirements that are largely outdated. A 2003 California court said that the trial court record in a scent lineup case was devoid of any evidence to indicate that a Labrador retriever was “of a breed, stock or pedigree characterized by acute powers of scent and discrimination.”⁵⁴

Suspects have been held not to have a right to counsel present during the conduct of a scent lineup.⁵⁵

Records of Alerts

Tracking cases often show only superficial interest in the background of a dog.⁵⁶ In a 1947 Georgia case, tracking evidence was admitted because an experienced handler “vouched for the breeding, accuracy, and reliability of the dogs.”⁵⁷ In a 1999 Colorado case, a handler testified that his dog had been unsuccessful in only 14 of 480 training sessions, and the witness attributed those cases where the dog was unsuccessful to handler error rather than to any failure of the dog.⁵⁸ A 2006 Texas case cited a handler’s testimony that one dog had performed 760 scent lineups, identifying the wrong subject only twice.⁵⁹

Although the handler’s interpretation of a dog’s actions as a positive alert is seldom questioned, objections have occasionally been raised concerning different reactions of a dog being interpreted as positive alerts.⁶⁰ In a 1978 Arizona case, a defendant objected that the records of a dog’s past failures were not described in its history. The Arizona Court of Appeals acknowledged that “a record of failures should be kept to substantiate the continued reliability of the dog,” but determined that the defect alone did not make the foundation insufficient.⁶¹ In a 2009 California case, a defense expert could not interpret the handler’s training logs and stated that he could not therefore assess the dog’s reliability. Nevertheless, the handler testified he was not aware that his

⁵⁴ California v. Mitchell, 110 Cal.App.4th 772, 2 Cal.Rptr.3d 49 (Ct. App. 2003).

⁵⁵ Jennings v. Texas, 2009 WL 167858 (Ct. App. 2009) (lineup was not “critical stage” of proceedings; objection that commenter on video was within hearing range of handler while video was made was held harmless error, if error at all).

⁵⁶ Hinton v. Mississippi, 175 Miss. 308, 166 So. 762 (1936) (dog came from good kennel; registration papers unnecessary); Bullock v. Kentucky, 249 Ky. 1, 60 S.W.2d 108 (Ct. App. 1933) (handler permitted to testify concerning dog’s accuracy).

⁵⁷ Mitchell v. Georgia, 202 Ga. 247, 42 S.E.2d 767 (1947).

⁵⁸ Colorado v. Brooks, 975 P.2d 1105, 81 A.L.R.5th 779 (1999).

⁵⁹ Robinson v. Texas, 2006 WL 3438076 (Ct. App. 2006).

⁶⁰ Arizona v. Roscoe, 145 Ariz. 212, 700 P.2d 1312 (1984) (different alert responses detracted from reliability of handler’s interpretations). See U.S. v. Clarkson, 551 F.3d 1196 (10th Cir. 2009), on remand, 2009 WL 1651043 (D.Utah 2009) (narcotics detection dog’s alert could not support probable cause for search of vehicle when dog’s alerts varied outside and inside the car and a video of the traffic stop was inconsistent with the handler’s description of the dog’s alerts; a defense expert opined that the handler may have cued the dog to alert in any case; the defense expert doubted the dog was adequately trained given that the handler was considering changing the dog’s alert from a passive alert to an active alert).

⁶¹ Arizona v. Coleman, 122 Ariz. 130, 593 P.2d 684 (Ct. App. 1978) (dog scented to footprints outside the home of attack victim led police to housing project where it alerted to the defendant, standing outside the project).

dog had made any mistakes in 171 lineups and the court found the handler's testimony sufficient to qualify the dog and admit the evidence concerning the lineup.⁶²

The authors believe that the records of a scent identification dog should not only be subject to discovery,⁶³ but should be maintained and to a reasonable degree verified by neutral organizations or government units. Further, the absence of such records should not be able to withstand defense objection.

Who is the Witness?

As with tracking cases, the question may be asked as to who the witness really is when a handler or observer describes the alert of a scent identification dog. An early Ohio case said that in tracking evidence, it is really the dog that is the witness, and hearsay at that. The court connected the risks of bloodhound evidence with the charge to the jury.

[I]t is the human testimony that makes the trailing done by the animal competent, and its actions are described by human testimony, just as it would describe the operations of a piece of intricate machinery. When the above foundation [pure blood, stock characterized by acuteness of scent, trained in testing in tracking human beings, laid on trail where perpetrator had been], or one similar in effect and efficiency is laid, the acts of the animal may be described. But the court, when such evidence is admitted, should explain its purpose and limitations to the jury, in order that they may not be unduly impressed thereby.⁶⁴

The comparison of dogs to machinery appears in analyses of the scientific validity of scent lineups, as will be discussed below.⁶⁵ One court, in response to an attempt to assign error to the admission of tracking testimony in part because the dog could not be cross-examined, noted that photographs and exhibits also cannot be cross-examined but are nevertheless admissible if relevant, material and probative, if a proper foundation is laid.⁶⁶

Is the Handler an Expert?

Tracking cases have recognized handlers as experts, but have also acknowledged that such expertise was generally not of a strictly scientific sort. In a 1999 case, the Colorado Supreme Court observed:

⁶² California v. White, 2009 WL 3111677 (Ct. App. 2009).

⁶³ See Debruler v. Kentucky, 231 S.W.3d 752 (2007) (failure to provide defense counsel with dog's training records was not reversible error because they had not been requested by defense counsel and were not covered by defense counsel's request for "results or reports of physical or mental examinations, and of scientific tests or experiments made in connection with the particular case;" counsel was "well aware that the Commonwealth would be presenting evidence of dog tracking, but failed to request the desired documents prior to trial." Presumably records would have been discoverable if requested.).

⁶⁴ Ohio v. Dickerson, 77 Ohio St. 34, 68, 82 N.E. 969, 976 (1907). See Pennsylvania v. Michaux, 360 Pa.Super 452, 520 A.2d 1177 (Super. Ct. 1987) (quoting *Dickerson* but disagreeing with the hearsay designation).

⁶⁵ See Colorado v. Brooks, 975 P.2d 1105, 81 A.L.R.5th 779 (1999); California v. Mitchell, 110 Cal.App.4th 772, 2 Cal.Rptr.3d 49 (Ct. App. 2003).

⁶⁶ Starkes v. U.S. 427 A.2d 437 (D.C. Ct. App. 1981).

Although we acknowledge that Officer Nichols offered his thoughts on how bloodhounds might pick up scent, this was not the substantive thrust of his testimony. Instead, Nichols focused on Yogi's training, reliability, track record, and performance in the case at hand—all matters based on specialized knowledge he obtained as Yogi's handler. Contrary to Brooks' [the defendant's] assertions, the reliability of scent tracking evidence is not dependent on the scientific explanation of canine olfaction.⁶⁷

The court argued that almost all testimony has some scientific aspect:

Brooks' [the defendant's] arguments suggest that whenever one can find “science” by scratching beneath the surface of expert testimony, the validation rules governing scientific evidence would have to apply. We reject this view. Nearly any topic that might be the subject of courtroom testimony can be characterized in such a way as to expose scientific principles. This is simply inescapable because the human experience takes place in the physical world—a world we explain with the laws of physics, chemistry, mathematics, and the like. Even a common eyewitness identification by way of lay testimony could involve “science” if one were to examine the scientific principles that underlie human vision and perception. The fact that some aspect of a witness' testimony can be *described* in scientific terms does not mean, *ipso facto*, that the jury must understand the science in order to find the testimony helpful. Instead, the courts should determine whether the opinion being offered either depends on scientific axioms, or is based on scientific theory, analysis, or experimentation.⁶⁸

This argument ignores the fact that the accuracy of visual lineups, as will be discussed below, has been the subject of research demonstrating that considerable inaccuracy can be shown to arise. It may be that the court did not consider statistical validity as an aspect of scientific analysis.

A South Carolina tracking case from 2007 described a handler's testimony as that of an expert, but elaborated on what that meant:

Gunter's testimony verified he had acquired, by training and experience, such knowledge and skill in the area of dog handling and tracking that rendered him better qualified than the jury to form an opinion on the particular subject of dog tracking. Furthermore, Gunter's testimony was based on his specialized knowledge, skill, and experience in the use of a scent-tracking dog, rather than on the validity of dog tracking as a scientific procedure. The nature of Gunter's testimony is analogous to that offered by a typical police officer who qualifies as an expert based on his experience with narcotics, not on his ability to explain the scientific theory behind his opinion. As such, the evidence Gunter [helps] the jury understand the evidence or resolve a factual issue.⁶⁹

⁶⁷ Colorado v. Brooks, 975 P.2d 1105, 1112, 81 A.L.R.5th 779 (1999).

⁶⁸ Id.

⁶⁹ South Carolina v. White, 372 S.C. 364, 642 S.E.2d 607 (Ct. App. 2007) (the witness had qualified as an expert in other cases).

A handler in a 1982 Virginia case qualified as “an expert in the training, handling, and ‘reading’ of tracking dogs.”⁷⁰

A 2002 Texas case considered the admissibility of the handler’s testimony as requiring answering a series of questions. Was the field of expertise a legitimate one? Because of the admissibility of canine evidence in a number of contexts and the fact that cases had concluded dogs could distinguish humans by scent, this question was answered in the affirmative. The next question was whether the expert’s testimony relied on the principles of the field. This required that the handler and dog were qualified and that the lineup was objective. The handler’s credentials were deemed sufficient. The dog’s qualifications turned out to be the traditional tracking dog foundation. The court held that the testimony was properly admitted.⁷¹

In a 2003 case,⁷² the California Court of Appeals felt the distinction between tracking and scent lineups could go to the admission of expert testimony and praised the trial court in the case before it for declining to admit the testimony of an expert whose sole experience was in tracking and trailing.⁷³ The trial court was criticized, however, for allowing two handlers to testify as to how long scent could remain on an object (two to four months), but “no effort was made to present information from any academic or scientific sources, let alone peer review journals,” regarding these testimonial assertions.⁷⁴ The court also noted that the handlers, who did not have scientific backgrounds, were unable to cite any scientific data supporting the notion that each individual has a unique scent. The court found that the dog performing the scent identification “analogous to a machine that [the handler] can calibrate and read.” Therefore, scientific standards under *Kelly*⁷⁵ “should have been applied to this evidence.” In the very next paragraph, however, the court seems to consider that modifying the foundational requirements in scent identification cases might obviate the need for a *Kelly/Frye* type of analysis.

We further conclude that, even if *Kelly* were not deemed to apply to scent identification evidence in general, a greater foundation than the one provided here is needed for its admission. In tracking and trailing, there is a history of canine performance which provides the basis for the [the requirement that] the dog was put on a fresh trail. For scent identification to be relevant, there must be some basis for assumptions made about degradation and contamination of scent, both

⁷⁰ *Epperly v. Virginia*, 224 Va. 214, 294 S.E.2d 882 (1982). Presumably “reading” refers to the handler’s ability to recognize when a dog is alerting.

⁷¹ *Winston v. Texas*, 78 SW3d 522 (Ct. App. 2002).

⁷² *California v. Mitchell*, 110 Cal.App.4th 772, 2 Cal.Rptr.3d 49 (Ct. App. 2003).

⁷³ The court noted, for instance, that the requirement of tracking cases that the trail not be stale required a “dramatic revision” for application to scent lineups.

⁷⁴ See also *California v. Gutierrez*, 2004 WL 723161 (Ct. App. 2004) (“In the absence of an adequate foundation from scientific or academic sources as to how long the scent would remain at the location, whether every person has a unique scent such as to permit an accurate basis for scent identification, the powers of the dog as to scent and discrimination, and the adequacy of the certification procedures for scent identifications . . . , the evidence was erroneously admitted in this case.” Nevertheless, the court found the admission of the evidence to be harmless error.)

⁷⁵ *California v. Kelly*, 17 Cal.3d 24, 549 P.2d. 1240, 130 Cal.Rptr. 144 (1976) (adopting *Frye* standard in California).

before and during collection, as well as the uniqueness of each person's odor, beyond the mere experiences of one trainer and one dog.⁷⁶

This demonstrates a healthy recognition that scent lineups are substantially scientific procedures, and should not be admitted solely on the foundational elements that have been applied historically in tracking cases.

SCENT LINEUPS OF PEOPLE

Older cases, following tracking experience or visual lineups of suspects before an eyewitness, allowed the dog to choose from a line of individuals, one of whom was generally a suspect while the others were foils. More recently, perhaps partially in response to research and protocols in European and FBI scent lineups, dogs have usually had to choose between a number of similar or identical objects, one of which was scented by a suspect while the others were scented by foils (a procedure sometimes referred to as “scent matching”).

In a 1923 Iowa case, a taxi driver arrived home and an explosion of dynamite at the side door of his house injured him so badly that he soon died. The police cordoned off the area and kept car lights on it to avoid anyone leaving additional footprints or handling objects. It appeared that the defendant had attempted to buy explosive materials in the days before the murder, and that prior to that he had begun an affair with the victim’s wife. About 2 p.m. the next day, two bloodhounds were taken to the end of the wires that led from the step under which the explosive device had been placed to a field where someone had apparently laid in wait for the victim. They took a scent. The circumstances at the jail are described in more detail in the handler’s own words:

“I took my dogs into the sheriff’s office and the sheriff says, ‘We will have the men walk by the dogs,’ and he says, ‘I want you to see if you can pick the man that we have and see if we have the right man or not if the dogs know.’ I did not know who the man was. He was a perfect stranger to me, and I didn’t know what kind of a looking man he was. There was quite a few fellows came in the sheriff’s office and came by and the dogs stood at leisure right side of me. I didn’t have no strings on them or nothing. There was probably five or six men went by and then there was three men came in and started by. When they came up by us both dogs turned and begun to kind of swing their heads and went over to this one man. They smelled of him, and he kind of held his hands up like this. One dog was smelling of his shoes, and the other kind of smelling around here on him.”⁷⁷

The Iowa Supreme Court did not admit the evidence, joining those states that rejected bloodhound testimony. This was one of the earliest U.S. cases that could be called a scent lineup, though it was unusual in that the suspect and the foils walked past the dog rather than the dog encountering these persons in a static line.

Courts have seldom made much of a distinction between such human lineups and scent matching or object lineups, but in one Sixth Circuit decision, a concurring judge noted that the handler had described the dog’s training as involving scent lineups of

⁷⁶ California v. Mitchell, 110 Cal.App.4th, 793-4.

⁷⁷ Iowa v. Grba, 196 Iowa 241, 194 N.W. 250, 257 (1923).

objects, but the lineup admitted in evidence in the case involved the actual suspect and an unstated number of human foils. Although finding this a defect, the judge nevertheless felt there was enough other evidence for the conviction to stand.⁷⁸

In a Maryland case, a tracking dog was scented on a cap that the perpetrator wore during a rape and that was left at the crime scene. The dog tracked to a road and then lost the trail where tire tracks were found. Three hours later, the dog was scented on the cap again and placed across from a line of police officers standing about five feet apart, with the defendant in the middle of the line. Roberts was a “black male, approximately 5 feet 7 inches tall and of stocky build,” but the races of the foils were not stated, though the dog was familiar with all of them. The court found this familiarity with the foils irrelevant but did not remark on the fact that the lineup was obviously not blind. The dog alerted to the defendant in two lineups, which seem only to have differed in the configuration of the suspect and the foils.

We have also surveyed to some extent the general literature concerning tracking dogs and find no indication that a trained and reliable tracking dog will signal a find because the person found is the only one unfamiliar to the dog from among a group of persons. To the contrary, so far as we can determine from the literature, the purpose of training a tracking dog is to keep it focused on the given scent and undistracted by other scents.⁷⁹

Thus, the purpose of training was determined to be the result produced. The court noted that tracking involves a sort of lineup whenever the dog tracks over an area traversed by one or more human beings other than the subject.

In two opinions involving different defendants but the same criminal enterprise,⁸⁰ the defendants led police on a high speed chase during which they threw cocaine bricks out of the car. The bricks were recovered and scent was taken by putting gauze pads beside them in an evidence bag. The defense objected to the introduction of the lineup evidence because the lineup was not conducted as a double-blind procedure (i.e., the handler knew who the defendant was in each lineup), the same officers participated as foils in both lineups, and the defendants were handcuffed during the lineups while the officers were not (which would have made it obvious who was the suspect even if the handler had not been told). Also, Risher was African-American and was thus easily distinguishable in a lineup of five Caucasian officers. One court, however, found that enough precautions had been taken to legitimate the lineup:

Officer Oglesby took affirmative steps to administer the scent lineup objectively by: (1) keeping the officers that handled the cocaine out of the lineup; (2) having two scent lineups, one for the appellant and one for the co-defendant; (3) having the officers stand in a similar fashion as the appellant, with their hands behind their back; and (4) repositioning the officers and the lineup location between each

⁷⁸ U.S. v. Gates, 680 F.2d 1117 (6th Cir. 1982) (conurrence of Judge Cornelia Kennedy).

⁷⁹ Roberts v. Maryland, 53 Md.App. 257, 452 A.2d 1271 (Ct. Spec. App. 1982), aff’d, 298 Md. 261, 469 A.2d 442 (Ct. App. 1983).

⁸⁰ Martinez v. Texas, 2006 WL 3720136 (Ct. App. 2006); Risher v. Texas, 227 S.W.3d 133 (Ct. App. 2006).

lineup. Moreover, Officer Oglesby testified he used both the manual from the National Police Bloodhound Association and his training with other dog handlers in his practice of scent identification.⁸¹

Suspect lineups have been disapproved of in Europe for a long time. As long ago as 1936, one classic of dog research stated:

It is still more dangerous to let a dog choose a person out of a row of people on the score of the odour of an object offered to the dog. Even if the trainer knows nothing about the test, and has himself no suspicion of anybody, there still remains the possibility, by no means a light one, that the dog may respond to the faintest movement of one of those persons.⁸²

Scent lineups with real people also have the disadvantage of allowing the dog to interact with the subjects, making it difficult to interpret a dog's reactions. It is to be hoped that this concern will be acknowledged by American courts.

Figure 1 summarizes procedural elements of human scent lineup cases. Common defects found in human lineups include using other police officers familiar to the handler and the dog as foils,⁸³ having the defendant handcuffed during the lineup,⁸⁴ and having foils all of a different race from the suspect in the lineup,⁸⁵

Figure 1: Human Scent Lineups (excluding tracking and station identifications)				
Case	Scenting Item	Suspect	Foils	Result
State v. Grba , 196 Iowa 241, 194 N.W. 250 (Iowa Sup. Ct. 1923).	Location where perpetrator probably lay in wait for victim (murder)	Two English bloodhounds alerted to suspect (not distinguished from foils)	Five or six men went by the dog, and another three came near	Admitted by trial court but Iowa Supreme Court rejected bloodhound testimony
U.S. v. Gates , 680 F.2d 1117 (6 th Cir. 1982) (case arose in Ohio)	Sandal dropped by suspect fleeing bank after robbery; sandal had been placed in vault 8 months before lineup	Suspect was in room with foils, but characteristics of lineup participants not described	Number of foils not stated	Testimony of handler admitted; concurring judge noted handler's usual lineup involved objects, not people, but said error was harmless
Roberts v. State , 53 Md.App.	Cap worn by perpetrator during rape and	Suspect in lineup that could not be	Line of 4 police officers standing about	Suspect alerted to; 3 hour time from first

⁸¹ Martinez v. Texas, 2006 WL 3720136, 2.

⁸² Buytendijk (1936), 100.

⁸³ Roberts v. Maryland, 53 Md.App. 257, 452 A.2d 1271 (Ct. Spec. App. 1982), aff'd 298 Md. 261, 469 A.2d 442 (Ct. of Appeals 1983).

⁸⁴ Martinez v. Texas, 2006 WL 3720136.

⁸⁵ Risher v. Texas, 227 S.W.3d 133 (Ct. App. 2006).

257, 452 A.2d 1271 (Ct. of Special Appeals 1982), aff'd, 298 Md. 261, 469 A.2d 442 (Ct. of Appeals 1983)	stored in plastic evidence bag; dog had previously tracked from crime scent to road where tire tracks may have indicated perpetrator drove away; dog was re-scented to cap 3 hours later for lineup	fully blind because dog and handler knew other lineup participants	5 feet apart; races of foils not stated; at least one officer was in civilian clothes	scenting found irrelevant by court
	Dog was put back in vehicle and brought back for 2d lineup		Positions of individuals in lineup altered	Dog alerted to suspect
Martinez v. State , 2006 WL 3720136 (Court of Appeals, Houston (14 th Dist.) 2006)	Cocaine bricks thrown from car during high speed chase; sterile gauze pad put in plastic bag where officers had placed recovered bricks of cocaine	Defendant was only participant in lineup who was handcuffed so lineups were not blind	Same 5 Caucasian police officers used as foils in two lineups with two defendants, repositioned after first lineup	Testimony admitted because of “affirmative steps to administer the scent lineup objectively” by keeping officers who handled cocaine out of lineup, having a lineup for each defendant, officers standing in similar fashion to suspect, and repositioning officers
Risher v. State , 227 S.W.3d 133 (Tex. Ct. of Appeals 2006)	Scent pad from same bricks used in Martinez case	Defendant was only African-American in lineup with 5 Caucasian officers, only individual handcuffed in lineup, so not blind	Officers repositioned after lineup for defendant Martinez	Defense objection that lineup should have consisted of scent pads only was not accepted by handler who preferred human lineups
People v. Schoppe-Rico , 140 Cal.App.4 th	Sweatshirt among clothes identified by witnesses as those worn by	Eyewitness lineup produced “less than	3 “randomly selected deputy sheriffs stood at locations	Appellate court found admission of scent lineup evidence without

1370 (2006)	perpetrator	compelling” evidence	equidistant from a central point;” seems likely lineup was not blind	<i>Kelly/Frye</i> hearing was harmless error because of other evidence
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SCENT MATCHES

The dog may be scented to an object found at the crime scene, or most commonly in tracking cases, by being taken to the crime scene itself.⁸⁶ Lineups where a dog is scented on an object thought to have been touched by the perpetrator and then given a choice of objects, most of which are scented by foils but one of which is scented by a suspect, is sometimes distinguished from a scent lineup and called a scent match, but is generally referred to as a type of scent lineup.⁸⁷

Scent lineups involving objects, just as with scent lineups of humans, can involve scenting the dog to a wide range of objects, including an electrical cord used to tie up a victim⁸⁸ and legal documents the suspect may not have handled for a considerable time.⁸⁹ Scent pads are sometimes rubbed against objects touched by the perpetrator at a crime scene to obtain a scenting item.⁹⁰ Shell casings can be used to place scent on gauze pads through scent transfer units, a technology that will be discussed below.⁹¹ Seats and steering wheels of vehicles have also provided scent,⁹² sometimes through use of scent transfer units.⁹³

⁸⁶ Connecticut v. Kelly, 2009 WL 323481 (Super. Ct. 2009) (dog scented to cash register knocked off counter during armed robbery, tracked down street to hat, which he picked up and thrashed, which handler interpreted as having the same scent the dog was following; dog then led to car in which two men were sitting and alerted, which handler interpreted as indicating car also had same scent; after men left car, dog jumped through open window and alerted to driver’s seat, which handler interpreted as meaning the scent from the cash register was also on the driver’s seat; letting dog in car to sniff driver’s seat was held not to be a violation of privacy).

⁸⁷ A somewhat different procedure, sometimes called a reverse and check, involves scenting the dog to the suspect and then matching this scent to *corpus delicti* placed in the lineup. For an American example see U.S. v. McNiece, 558 F.Supp. 612, 12 Fed.R.Evid.Serv. 1870 (E.D.N.Y. 1983), discussed below.

⁸⁸ Robinson v. Texas, 2006 WL 3438076 (Ct. App. 2006), 2009 WL 5205361 (Ct. App. 2009) (also wallet from which perpetrator took cash).

⁸⁹ Buchanek v. City of Victoria, 2009 WL 500564 (S.D.Tex. 2009), 2010 WL 1268069 (S.D.Tex. 2010) (suit for wrongful search, seizure, and investigation).

⁹⁰ Winston v. Texas, 78 SW3d 522 (Ct. App. 2002) (scent pad taken from microwave moved during burglary); Thomas v. Texas, 297 S.W.3d 458 (Ct. App. 2009) (scent on currency taken from robbery suspect matched to scent of victim; procedure not specified).

⁹¹ California v. Mitchell, 110 Cal.App.4th 772, 2 Cal.Rptr.3d 49 (Ct. App. 2003).

⁹² Isler v. Texas, 2010 WL 724172 (Ct. App. 2010) (scent pad rubbed on seat where defendant sat in one car supposedly matched in lineup of six paint cans to scent pad rubbed on seat where defendant sat in another car; foil scents taken directly from prisoners at a different time from target scent).

⁹³ California v. Aguilar, 2004 WL 2051385 (Ct. App. 2004) (scent pads prepared from passenger seat of Volkswagen where shooter had been seated according to witnesses; handler had said scent would last on car seat for five days, but car had not been impounded until 15 days after crime; trial court had admitted evidence but appellate court held its admission harmless error given testimony of three eyewitnesses); see also Aguilar v. Woodford, 2009 WL 509127 (C.D.Cal. 2009) (habeas corpus); California v. Sanders, 2009 WL 3682460 (Ct. App. 2009) (swab of steering wheel used to scent dog, which found batting glove in bushes after about 45 minutes of trailing; dog later alerted to car in which defendant had been placed).

If an object may have been touched by other individuals besides the perpetrators, an effort is often made to exclude these scents in tracking cases. In a 2009 Texas case,⁹⁴ items in a burglarized house from which scent pads were collected were probably also touched by members of the household, so the bloodhound was taken to the scent to sniff members of the household with the hope that the dog will then try to find the “missing member”—the individual whom he has yet to sniff. The effectiveness of the missing member procedure has been questioned by handlers, though the issue is of greater significance in tracking cases where the dog might actually begin tracking someone innocent.⁹⁵

A lineup may include an object found at the crime scene or taken from the victim and similar objects, such as clothing,⁹⁶ towels,⁹⁷ sheets,⁹⁸ tools,⁹⁹ or the butt of a marijuana cigarette,¹⁰⁰ that the perpetrator is assumed to have contacted.¹⁰¹ In some cases the lineup may be used to determine if the victim contacted an object. Vehicles have been lineup objects.¹⁰² A Virginia case involved scenting a dog to a towel the victim had likely touched in a parking lot containing the suspect’s car, to which the dog alerted. This was taken as evidence that the victim had been transported in the suspect’s car.¹⁰³ Bicycles have also been lineup objects.¹⁰⁴

Lineup objects should be as similar as possible. A lineup is suspect if only the target object has blood, which may make the item attractive to the dog.¹⁰⁵ A lineup of

⁹⁴ Perkins v. Texas, 2009 WL 2837356 (Ct. App. 2009) (gauze pads were rubbed over objects possibly touched by burglars; dogs sniffed members of household so dogs could isolate scent of missing member in scent lineup).

⁹⁵ Schettler (2010), 35, 38. See, e.g., Cranford v. Arkansas, 130 Ark. 101, 197 S.W. 19 (1917).

⁹⁶ Arizona v. Roscoe, 145 Ariz. 212, 700 P.2d 1312 (1984) (dog scented to clothing of suspect for lineup of five articles of clothing, one of which had been worn by the murdered victim; alert taken as evidence suspect had touched victim’s clothing); Ramos v. Texas, 496 So.2d 121 (1986) (lineup of five shirts, four belonging to one foil, one worn by victim during assault and murder and the only one with blood on it).

⁹⁷ Epperly v. Virginia, 224 Va. 214, 294 S.E.2d 882 (1982)

⁹⁸ Dedge v. Florida, 442 So.2d 429 (Ct. App. 1983) (dog scented to paper towels used by suspect alerted to victim’s sheets in lineup of 5 sheets, but only on second pass in lineup; foil sheets were supplied by other prisoners).

⁹⁹ U.S. v. McNiece, 558 F.Supp. 612, 12 Fed.R.Evid.Serv. 1870 (E.D.N.Y. 1983) (dog scented to sock worn by suspect and given an array of tools, including boltcutters used in break-in at postal station; lineup occurred 21 days after crime).

¹⁰⁰ California v. Hackett, 2003 WL 463976 (Ct. App. 2003) (as well as glove left at crime scene, both scents enhanced by scent transfer unit; court did not decide on assignments of error, finding admission harmless error).

¹⁰¹ Perkins v. Texas, 2009 WL 2837356 (Ct. App. 2009) (scent pads rubbed against objects in room where burglar had taken items).

¹⁰² See Arizona v. Roscoe, 145 Ariz. 212, 700 P.2d 1312 (1984) (dog scented to clothing of murder victim, alerted to suspect’s car in lineup of four other cars; taken as evidence victim had been in car).

¹⁰³ Epperly v. Virginia, 224 Va. 214, 294 S.E.2d 882 (1982) (“numerous” cars were in lot; procedure took place 14 days after suspect’s disappearance; dog subsequently went into police station and alerted to suspect, who said three times, “That’s a damn good dog;” court accepted handler’s testimony that dog had followed trails as old as 21 days).

¹⁰⁴ Arizona v. Roscoe, 145 Ariz. 212, 700 P.2d 1312 (1984) (lineup of five bicycles, including victim’s; alert taken as evidence suspect had touched bicycle victim was riding during period of her disappearance).

¹⁰⁵ Ramos v. Texas, 496 So.2d 121 (1986) (in lineup of five shirts, only one shirt, the victim’s had blood on it; also lineup of five knives, only one of which, that found in victim, had blood on it; dog licked the knife with blood, suggesting attractiveness may have caused identification); Epperly v. Virginia, 224 Va. 214, 294 S.E.2d 882 (1982) (towel found along trail and used in lineup may have had blood).

sheets where one was from the victim and four were from prisoners may also be questioned.¹⁰⁶ One case involving a lineup of scent pads included one obtained by swabbing the arm of a suspect.¹⁰⁷ Foils consisted of scent pads obtained from individuals of the same ethnic background, but these samples appeared to be part of the handler's inventory for conducting scent lineups and there was no showing that they had been obtained in the same manner as the pads from the suspects, or that scent was added at the same time.¹⁰⁸

Time has sometimes been considered by courts in analyzing scent matching lineups. A conviction involving a scent lineup occurring at least three months after the crime was reversed, though primarily based on the exclusion of the testimony of a defense expert.¹⁰⁹ An object lineup occurring 21 months after a burglary was admitted, with the possible staleness of the evidence going only to the weight of the evidence, not its admissibility.¹¹⁰ Figure 2 summarizes procedural elements of scent lineups involving odor matches of objects.

¹⁰⁶ *Dedge v. Florida*, 442 So.2d 429 (Ct. App. 1983).

¹⁰⁷ Cases may not describe how scent pads were prepared or even the number of pads used in a match. See *California v. Demirdjian*, 2003 WL 1963204 (Ct. App. 2003), *Demirdjian v. Sullivan*, 2009 WL 2767673 (C.D.Cal. 2009) (habeas corpus; scent match conducted 19 days after scenting pad prepared; no mention of foils).

¹⁰⁸ *Perkins v. Texas*, 2009 WL 2837356 (Ct. App. 2009) (scent pads rubbed against objects in room where burglar had taken items); see also *Buchanek v. City of Victoria*, 2009 WL 500564 (S.D.Tex. 2009), 2010 WL 1268069 (S.D.Tex. 2010) (same handler, Keith Pikett).

¹⁰⁹ *Dedge v. Florida*, 442 So.2d 429 (Ct. App. 1983) (defendant was again convicted in a second trial, but exonerating DNA evidence resulted in defendant's release in 2004).

¹¹⁰ *U.S. v. McNiece*, 558 F.Supp. 612, 12 Fed.R.Evid.Serv. 1870 (E.D.N.Y. 1983).

Figure 2: Scent Lineups With Objects			
Case	Scenting Item	Lineup Elements	Result
Epperly v. Commonwealth , 224 Va. 214, 294 S.E.2d 882 (1982)	Suspect's underwear (also used for tracking preceding lineups)	Towel found along trail dog had followed, along with five similar blue towels; disappearance was on night of June 28, trailing on July 10; target towel may have contained blood	Dog "ran immediately" to towel found along trail
	Blue towel that had been found on trail	On July 12, "numerous vehicles" were in parking lot	Dog alerted at driver's door of suspect's car
	Still scented on blue towel	Dog went into police station to door of office where suspect was seated	Suspect said "That's a damn good dog," three times; canine evidence admitted
U.S. v. McNiece , 558 F.Supp. 612, 12 Fed.R.Evid.Serv. 1870 (E.D. N.Y. 1983)	Sock worn by suspect	Room in which tools, including bolt cutters found at scene of postal station burglary were on floor, 21 months after crime	Dog alerted to bolt cutters; dog's alert was videotaped; motion to exclude videotape denied; time after crime went to weight, not admissibility of evidence
Dedge v. State , 442 So.2d 429 (Fla. Dist. Ct. of Appeal, 5 th Dist., 1983)	Bag of paper towels suspect had used; lineup at least 3 months after crime	Lineup of 5 sheets, one of victim and 4 of prisoners unconnected with suspect; dog only alerted on 2d pass of lineup objects	Dog alerted to victim's sheet, taken as evidence suspect had been in contact with it
	Not stated if dog was rescented after being taken to victim's house	Dog alerted in victim's house, arguably to items touched by suspect	Conviction reversed on exclusion of testimony of defense expert; new trial resulted in conviction; exonerating DNA evidence resulted in release in 2004
State v. Roscoe , 145 Ariz. 212, 700 P.2d 1312 (Az. Sup. Ct. 1984)	Clothing of murder victim; time after crime not specified but presumably at least a month since defendant came to police station more	Suspect's car in lineup with 4 other cars	Dog alerted to suspect's car, taken as evidence victim had been in the car

	than month after crime		
	Clothing of suspect	Dog taken to area where victim's bicycle was found; dog's actions suggested suspect had been in area	Closer to a trailing situation as the dog arguably found part of a trail; dog's alerts may not have been consistent according to defense objection, but issue was not discussed by court
	Clothing of suspect	5 articles of clothing, 1 of which was victim's	Dog's alert to victim's clothing taken as evidence suspect had touched the clothing
	Presumably clothing of suspect	5 bicycles, including victim's	Dog's alert to bicycle taken as evidence suspect's scent was on it; death sentence was affirmed
Ramos v. State , 496 So.2d 121 (Tex. Sup. Ct. 1986)	Cigarette pack suspect had held during interrogation; lineups occurred day after interrogation (but length of time since crime not specified, presumably short)	Lineup of 5 shirts, 4 of which belonged to husband of secretary of police chief and 1 of which was victim's and had blood on it	Dog alerted to victim's shirt; court reversed, noting only shirt with blood was victim's; court found testimony of handler insufficient to establish reliability of scent lineup as method of proof (though use of scent lineups not precluded generally)
	Cigarette pack	Lineup of 5 knives, 3 from local diner, 1 from police officer, 1 that had been imbedded in victim's body; dog licked knife, suggesting attractiveness	Dog alerted to crime scene knife on 2 passes; handler and investigating officer observed conduct of lineup, which meant it could not be fully blind
Winston v. Texas ,	Scent pad rubbed	5 scent pads, 1 touched	Court admitted

78 SW3d 522 (Court of Appeals, 14 th Dist., 2002)	against microwave oven moved by perpetrator	by suspect	scent identification evidence as based upon “experience and training” rather than on “scientific methods”
People v. Hackett , 2003 WL 463976 (Cal.App.2d Dist. 2003)	Glove and marijuana cigarette found at scene of murder, scent enhanced with scent transfer unit; time frame after crime not specified	Scent pads made from suspect’s prison clothing and scent pads with other people’s body odors	Court did not decide on objections, finding admission of the dog scent evidence to be harmless error if it was error
People v. Mitchell , 110 Cal.App.4 th 772, 2 Cal.Rptr.3d 49 (2003)	Scent pads created with scent transfer unit from shell casings found at scene of gang murder	Scent pads from seats of detectives in homicide bureau and pad from shirt of Mitchell, a suspect	Dog alerted to Mitchell’s scent pad; detectives believed suspect had loaded weapon used to kill victim
	Scent collected from shirt of Drake, the victim	Scent pads including pad from Mitchell	Dog alerted to Mitchell’s scent pad, perhaps because Mitchell turned over Drake after shooting him
	7 more lineups but scenting items not specified	Dog did not alert to any pads; no pads involved Mitchell	Scent lineup evidence used only against Mitchell, one of several defendants; court considered STU a “novel device used in furtherance of a new technique” but determined admission of scent evidence involving STU to be harmless error
People v. Demirdjian , 2003 WL 2003 WL 1963204 (Cal.App. 2 Dist. 2003), Demirdjian v. Sullivan , 2009 WL 2767673 (C.D. Cal. 2009)	Scent pad created from bloodstained rock at crime scene; scenting item prepared after crime on July 23 but matching occurred on August 11, 2000	Dog alerted to a scent pad with defendant’s scent on it; no information as to number of foils, if any	Habeas corpus petition denied

(habeas corpus)			
People v. Robinson , 2004 WL 2418068 (Cal.App.2 Dist. 2004) (admission sought by defense as exonerating)	Cap found at murder scene, assumed to be worn by perpetrator	Lineup at police station day after crime	Dog alerted to pad prepared by suspect who was not charged; proper use of STU 100 not established and scientific validity not established
People v. Aguilar , 2004 WL 2051385 (Cal.App. 2Dist. 2004); see also habeas corpus review, Aguilar v. Woodford , 2009 WL 509127 (CD Cal. 2009)	Scent pads prepared from seat of VW 41 days after car was used in shooting	Scent pads prepared from clothing of suspect, put in line of 3 other pads; dog alerted to pad from suspect	Court found scent evidence “of questionable probity” but determined its admission to be harmless error
Robinson v. State , 2006 WL 3438076 (Ct. of Appeals 2006), 2009 WL 5205361 (Ct. of Appeals 2009)	Electrical cord used to tie up victim and wallet from which perpetrator took cash; not clear if dogs were scented to only 1 item per lineup	Lineup of paint cans containing gauze pads; initial decision mentions 3 dogs but only 2 described in 2009 decision, 1 of which did not sniff 3 cans	Appellate court held trial court did not abuse its discretion in admitting scent lineup
People v. Giles , 2008 WL 2436529 (Mich.App. 2008)	Scent pad from gun found near suspect; scent pad also prepared from bag containing cocaine but no results of matching indicated as to this scent source	Scent from coat worn by suspect (number and type of foils not described)	Officer may have conducted “scent lineup” at his home; reported a match between scent of gun and scent from coat
Winfrey v. State , 291 S.W.3d 68, 2009 WL 1636849 (Ct. App. 2009), rev’d 2010 WL 3656064 (Ct. Crim. App. 2010)	Scent pads prepared from touching the pads to clothing worn by the murder victim	Texas Ranger also obtained scent pads from 4 suspects; lineup conducted 19 days after crime; scent pads were placed in 6 cans and 2 dogs alerted to suspect Richard Winfrey, but not to another suspect; Ranger Huff chose positions of pads, not handler	Handler concluded Winfrey left scent on clothing of victim
	Scent pads prepared from touching the pads	Foils were scent pads prepared by handler from individuals of same race	Handler concluded Megan Winfrey left scent on victim’s

	to clothing worn by the murder victim	and gender as female suspect, Megan Winfrey; dogs alerted only to can with suspect's scent	clothing
	Scent pads prepared from touching the pads to clothing worn by the murder victim	Lineup of suspect's scent and 5 foils; dogs did not alert to any scent	
Perkins v. State , 2009 WL 2837356 (Ct. of Appeals, 1 st Dist. 2009) (3 lineups of 3 suspects)	Gauze pads rubbed over objects likely to have been touched by burglars; dogs sniffed members of burglarized household so dog could isolate scent of "missing member"	Scent pads rubbed along arms of suspects; lineup of 6 silver canisters 10 ft. apart; after handler placed samples in canisters, his wife reordered the canisters in effort to make test blind; samples from black males from handler's stored samples used as foils; apparently separate lineups for each suspect; lineup in parking lot behind police station	Dogs alerted only to canisters containing scent of suspects; conviction was affirmed
People v. White , 2009 WL 3111677 (Cal.App.2Dist. 2009)	Shell casings wrapped in scent pads for about 10 minutes and placed in Ziploc bags	Scent of 4 individuals, including suspect's, collected by rubbing their arms and placed in boxes in diamond formation; officers setting up lineup were visible to handler	Dog alerted to box containing suspect's scent; appellate court was satisfied trial court had adequately considered scientific issues for admissibility; criticisms of defense expert went to weight not admissibility
Jennings v. State , 2009 WL 167858 (Tex.App.-Hous. (14 Dist.) 2009)	Defendant's scent	Scents from keys handled by perpetrator during robbery and scents from non-suspects in 5 other cans; lineup could not be blind after first alert	Dog alerted to scent from keys on second pass; 2 other dogs alerted on 1 st pass; procedure was videotaped with commentary by individual who could be heard by handler; court found harmless error
Buchanek v. City	Document suspect	Scents of foils were kept	Defense motions to

of Victoria , 2009 WL 500564 (SD TX 2009), 2010 WL 1268069 (S.D. Tex. 2010) (suit for wrongful search, seizure and investigation)	may not have handled for 2 years and had been handled by other people	by handler for lineup purposes (not clear when prepared); target object was rope found on victim's body; lineup may not have been blind	dismiss wrongful investigation suit denied
Isler v. State , 2010 WL 724172 (Tex.App.-Hous. (14 Dist.) 2010)	Pad rubbed on front passenger seat of vehicle where one perpetrator may have sat	Scent sample from one suspect (Redd) and 5 pads from prisoners collected earlier	3 bloodhounds alerted to suspect's scent; paint cans holding scent pads in lineup apparently not rearranged between dogs
	Pad rubbed on rear passenger seat where other perpetrator may have sat	Pad from seat in another car where suspect sat	Dogs were matching one car seat scent pad to another car seat scent pad; lack of defense objection meant issues regarding lineup were not preserved for appeal

Right to counsel has been held not to apply to scent matching lineups in a case where the lineup was videotaped and the commenter providing a voiceover was within hearing range of the handler.¹¹¹

THE CORROBORATION REQUIREMENT

Scent lineup opinions have often followed tracking cases in requiring that such evidence based on the behavior of dogs should not be sufficient in an of itself to convict.¹¹² European courts have considered corroboration important.¹¹³ A survey of judges in Poland found that only 22% of 41 judges presiding over criminal trials regard scent lineups as sufficient to convict a defendant where the lineup results were the only

¹¹¹ *Jennings v. Texas*, 2009 WL 167858 (Ct. App. 2009) (declining to overturn conviction on grounds lineup was “improperly suggestive,” and finding error harmless if there was one; court noted that video demonstrated that one dog missed the suspect’s scent on the first pass, but ignored fact lineup was not blind).

¹¹² See *Michigan v. Laidlaw*, 169 Mich.App. 84, 96, 425 N.W.2d 738, 743 (Ct. App. 1988) (“Due to varying skills of dogs and their handlers, as well as the possibility that a jury may give more weight to dog-tracking evidence than it is entitled to, there must be other corroborating evidence presented before identification is sufficient to support a guilty verdict.”).

¹¹³ Kaldenbach (1998), p. 130 (evidence corroborated by scent lineups includes statements made by the defendant to others indicating knowledge of the crime because facts in the statements had not been made public). See LJN AO03222 Court of Appeals—Hertogenbosch (February 9, 2004), summarized by Broeders (2006), 159 (knife with suspect’s scent dropped as evidence in re-trial after DNA evidence obtained).

evidence for conviction.¹¹⁴ A scientist and lawyer in Holland have argued that scent lineup evidence should only be admitted as corroborative of other evidence.¹¹⁵

A federal district court in New York found that the other evidence must be sufficient to establish a defendant's guilt by clear and convincing evidence. That combined with the scent lineup evidence would then have to be in total convincing beyond a reasonable doubt.¹¹⁶ The authors consider a corroboration requirement essential to the admission of scent identification evidence, and believe that a "clear and convincing" standard is appropriately applied to the corroborative evidence before there can be a conviction.

Corroborating evidence has sometimes seemed fairly weak.¹¹⁷ In one 2003 Texas case, a defendant was told the results of a lineup as a means of pressuring a confession, which was obtained.¹¹⁸ Canine evidence may sometimes be regarded as corroborative of other evidence.¹¹⁹

JURY INSTRUCTIONS

An early scent lineup case quoted an instruction admonishing the jury not to put too much weight on the evidence from a scent lineup, alluding to the "who is the witness" issue:

Evidence has been presented in this case that law enforcement authorities conducted portions of their investigation with the aid of a trained dog. Because it is of course not possible for the dog to communicate its findings to us directly, we must rely on the interpretation of the dog's actions provided by the testimony of its trainer, witness John Preston. Because of the nature of this evidence, you are instructed to receive it with caution and not to give it undue weight. It is to be considered as a part of, and along with, all the other evidence in the case in your deliberations.¹²⁰

A 1983 New York case concluded that scent lineup evidence could be considered by a jury but that the jury must:

¹¹⁴ Wojcikiewicz (2002). See also Oliver et al. (2009).

¹¹⁵ Frijters and Boksem (2004) (describing scent lineups as being almost like "Russian roulette"). Frijters has argued that the methodology of scent lineups used in Holland are sufficiently defective that they should no longer be used. Frijters (2006).

¹¹⁶ U.S. v. McNiece, 558 F.Supp. 612, 12 Fed.R.Evid.Serv. 1870 (E.D.N.Y. 1983).

¹¹⁷ Winfrey v. Texas, 291 S.W.3d 68 (Ct. App. 2009) (scent lineup corroborated by defendant's reference to himself as number one suspect and defendant's sharing of information he had heard about the murder, though without saying he was involved. The case was reversed by the Texas Supreme Court, which found the evidence "legally insufficient to support a conviction." Winfrey v. Texas, 2010 WL 3656064 (Ct. Crim. App. 2010).

¹¹⁸ Drake v. Texas, 123 S.W.3d 596 (2003) (no description of scent lineup in published opinion).

¹¹⁹ See Reyes v. Texas, 1997 WL 196356 (Ct. App. 1997) (dog's alert to bags in motel room tended to support testimony of a witness connecting defendant with drugs, but since bags did not contain contraband, corroboration was weak).

¹²⁰ U.S. v. Gates, 680 F.2d 1117, 1119 (6th Cir. 1982). See also Michigan v. Giles, 2008 WL 2436529 (Ct. App. 2008) (scent matching evidence was described as "tracking dog" evidence that jury was cautioned had "little value as proof").

1. Determine *beyond a reasonable doubt* that the dog, based on his previous lineup record, has demonstrated the ability to identify reliably and discriminate among “odors.”
2. Use the dog identification evidence to convict defendant only if the other evidence in the case establishes defendant's guilt by *clear and convincing evidence*.¹²¹

Thus, the court put the determination of corroboration on the jury, with different proof standards for two types of evidence.

Cautionary instructions are common through more than a century of tracking cases.¹²²

III. SCENT IDENTIFICATION RESEARCH

The rationale for canine identification of individual humans on the basis of scent for forensic purposes is that scent molecules characteristic for a person are left on objects touched by or having contact with that person. Scent lineup procedures have been accepted because a number of assumptions have guided police work with dogs in such procedures, including that individuals have unique odors,¹²³ such odors are stable over time,¹²⁴ dogs can differentiate between odors of individuals and can be taught to signal that two odors match and are produced by the same individual,¹²⁵ such signaling of identity will happen with approximately the same accuracy for any individual,¹²⁶ and that lineups can be designed to take advantage of these skills.¹²⁷

To support these assumptions, a number of lines of research must be considered that involve anatomical, physiological, and chemical analyses of canine olfaction and as well as testing of the reliability of dogs in identification procedures. Since hundreds if not thousands of papers have some relevance to such an inquiry, this section will attempt to review the more central areas of research concerning scent discrimination and identification.

CANINE PROCESSING OF SCENT INFORMATION

¹²¹ U.S. v. McNiece, 558 F.Supp. 612, 12 Fed.R.Evid.Serv. 1870 (E.D.N.Y. 1983).

¹²² See, e.g., North Carolina v. Spivey, 151 N.C. 676, 65 S.E. 995 (1909); Missouri v. Rasco, 239 Mo. 535, 144 S.W. 449 (1912); Ohio v. DeWitt, 2007 WL 1934335 (Ct. App. 2007).

¹²³ See, e.g., Schoon and Haak (2002), pp. 39 et seq.; Harvey et al. (2006) (arguing dogs may use a genetically derived odortype as the major source of scent while trailing, but can be confused more often by identical twins living together than identical twins living apart).

¹²⁴ See, e.g., Schoon and Haak (2002), p. 47; see also Harvey et al. (2006) (longer related persons live apart, the more easily distinguishable they are by dogs).

¹²⁵ See discussion of Schoon and Haak (2002), p. 48.

¹²⁶ Secondary and tertiary odor elements, as well as gender, have been shown to have little effect on a dog's ability to operate in scent identification procedures. On the other hand, dogs are attracted to some individuals in such a way that their identification of such individuals is less accurate than of individuals to whom they are not attracted.

¹²⁷ See the discussion of protocols below. Too often—in fact, almost always—U.S. cases have assumed high if not infallible identification skills of the dogs used in a case and allowed the handler to provide a protocol for taking advantages of those skills in identifying a suspect as the perpetrator. As the discussion of protocols will show, some procedures will produce much more reliable results than others.

A great deal of research describes the anatomy of the dog's nose and brain.¹²⁸ A dog can have difficulty processing scent information at a number of stages. Figure 3 summarizes where the processing of scent information can produce problems that might lead to misidentifications or no identification despite a positive match.¹²⁹

Figure 3: Possible Sources of Identification Errors Correlated with Stages of Scent Perception in Dogs	
Stage of scent perception	Problems that may cause errors in identification of scent
Scent molecules in nasal cavity	Molecules cannot reach receptor
Reaction of scent molecules with receptors	No proper receptor available for certain kind of molecules
Chemical reaction in sensory neuron	Sensory neuron does not react
Conduction of impulse through nerve	Nerve does not react
Processing of the impulse in the brain	Brain interprets the information incorrectly

Thus, the procedures by which a dog ultimately identifies a suspect's scent as equal to that of the perpetrator must be conducted in a manner to reduce potential physiological and chemical limitations of the scent identification dogs used in a particular test.¹³⁰

Diseases are also known to diminish olfactory function in the dog, including canine distemper, canine parainfluenza, Cushing's disease, allergic rhinitis, hypothyroidism, seizure disorders, nasal tumors, head trauma, diabetes mellitus, and chronic renal failure.¹³¹ Medications, such as steroids used to treat some of these conditions, may also alter a dog's olfactory capabilities.¹³² Hormonal changes might also reduce a dog's functioning.¹³³

It has also been recognized that different breeds of dogs have varying levels of genetic diversity in their olfactory receptors. Some breeds may have greater genetic expression in the ligand-binding capacity of receptors, which may affect scenting ability.¹³⁴

Ability of Dogs to Distinguish Scents

Scent identification presumes that dogs can distinguish one scent from a large number of scents, and there is ample evidence to support this general assumption.¹³⁵ A study by two

¹²⁸ For recent summaries see Schoon and Haak (2002), Gerritsen and Haak (2001).

¹²⁹ Adapted from Schoon (1999).

¹³⁰ See Furton and Myers (2001) (discussing physiological reasons that dogs may not perform well in detection assignments, particularly involving explosives detection).

¹³¹ See Furton and Myers (2001). Courts have occasionally recognized illness as influencing a dog's olfactory capacity. See *Ohio v. Knight*, 83 Ohio Misc.2d 79, 679 N.E.2d 758 (Ct. Com. Pleas 1997) ("The presumption of reliability obtained from the training and certification evidence may be thereafter attacked by evidence focused upon the training procedures, certification standards, or other factors, such as the health of the dog, which relate to the issue of reliability.").

¹³² Ezeh et al. (1992).

¹³³ Schoon (1998).

¹³⁴ Robin et al. (2009); Lesniak et al. (2008); Olender et al. (2004).

¹³⁵ Courts have been aware of the need for scent identification dogs to be able to distinguish among multiple scents.

Alabama scientists found that dogs could be rather easily trained to detect ten different odors and that the amount of time for training new odor discriminations tended to decrease as more odor discriminations were trained.¹³⁶ Dogs can remember these different odors for months,¹³⁷ and in the experience of some trainers, for years.¹³⁸ One study found that dogs could distinguish the odors of 17 men, women, and children, in a test that involved finding the handkerchief used by a specific person.¹³⁹ Yet another study looked at the ability of seven dogs to match scent samples with the people from whom they were taken. An 85% matching rate was found, but the dogs did not perform as well in the presence of observers.¹⁴⁰

HUMAN ODOR

Human scent can be described as a combination of various compounds differing in ratio from person to person along with some compounds that are specific to individuals. This combination of relative ratios may explain why each individual has a unique odor that a dog is able to detect.¹⁴¹ A useful terminology lists three factors as contributing to human odor:

1. *Primary odor.* Constituents of odor that are stable over time regardless of diet or environmental factors. This odor is probably genetically determined.¹⁴²
2. *Secondary odor.* Constituents present because of diet, environmental factors, disease, and medications.¹⁴³
3. *Tertiary odor.* Constituents present because of the influence of outside sources, such as lotions, soaps, perfumes, etc. These constituents will change as an individual's hygiene habits change.¹⁴⁴

Material used for odor sampling and the place odor samples are taken may also add constituents.¹⁴⁵

There are no articles that have just one human scent on them. That is what is referred to as layering or "layered scent." For example, if four people contributed scent to a crime scene—one victim, one assailant, one police officer and one crime technician, a dog handler is trained to have the victim, the police officer and the technician at the start of the trail and the dog is trained to follow the "missing member."

California v. Salcido, GA052057 (Super. Ct. 2005) (describing testimony of Rex Stockham).

¹³⁶ Williams and Johnston (2002).

¹³⁷ Williams et al. (1977).

¹³⁸ See Schoon (2003) (stored scent distinguishable after seven years); BBC Documentary, "Can Dogs Detect Cancer?" (2006).

¹³⁹ Kalmus (1955).

¹⁴⁰ Settle et al. (1994).

¹⁴¹ Curran et al. (2006). For additional discussion of possible biochemical bases of human odor, see Yamazaki et al. (1990); Yamazaki et al. (2001); Yamazaki et al. (1998).

¹⁴² Curran et al. (2007) (finding 63 human-produced compounds from the hands of 60 volunteers, and finding a high degree of variability, stating: "It is uncertain whether scent identity is distinguishable merely by ratios of the common compounds between individuals, the presence or absence of compounds which vary significantly between individuals, or if it is a combination of the two factors."); Schoon et al. (2009).

¹⁴³ Age has been found to affect the chemistry of human breath. Phillips et al. (2002).

¹⁴⁴ Curran et al. (2005).

¹⁴⁵ Jezierski et al. (2003).

Studies Relevant to Primary and Secondary Odor

A group of researchers collected sweat, urine, and saliva from 197 adults from a village in the Austrian Alps over a period of ten weeks, and then analyzed the volatile compounds in the samples. They detected 44 individual and 12 gender-specific volatile compounds. The researchers concluded that individuals had very distinctive chemical signatures and argued:

[O]dor may be analogous to facial features, in that no single measurement on a face can easily be used to recognize an individual; it requires a combination of features, and recognition is improved by including other traits.¹⁴⁶

Some changes in an individual's odor have been demonstrated to occur as a result of aging.¹⁴⁷ One group of researchers noted that it is generally possible to control for tertiary odors, but dealing with secondary odors is more difficult. The researchers noted that women might be at different phases of menstrual cycles, which might provide differentiating odors for dogs, but this is difficult to obtain data on.¹⁴⁸

Two researchers looking at volatile carboxylic acids secreted from axillary skin compared these odorant acids in 12 pairs of monozygotic twins. Variations were noted in the same subject if taken on different days, and this temporal difference was found to be only slightly lower than that between the identical twins. The researchers concluded that humans have a genetically determined body odor type that is at least partly composed of carboxylic acids.¹⁴⁹

Research Studies on Identification in Tracking and Trailing. A study of eight bloodhounds confirmed the ability of seasoned dogs to track in difficult conditions. The dogs were scented to pads which had been held by men and women of different ages and ethnic groups. These individuals laid trails that were from half a mile to a mile and a half in length. Through most of the trail, the trail layer, whose scent a bloodhound was supposed to follow, walked with a partner but about 50 feet from the end of the trail these two individuals separated and hid behind a nearby object, such as a tree or a building. Trails were laid in this manner in regional parks and on a college campus over surfaces that included grass, asphalt, cement, dirt and mud, wooden bridges, and a stream.

About 48 hours later, the trail layer and the partner were brought back to the end point of the trial and hid again. At the beginning of a trail the dog was given a "negative check," being scented to a gauze pad that had not been touched by either person who walked on the trail. Only after the dog did not begin to trail (since there was no trail to follow related to the scenting item) was it scented to a pad that had been touched by the trail layer. The test was terminated when the handler determined that the dog had made

¹⁴⁶ Penn et al. (2007).

¹⁴⁷ Phillips et al. (2000a); Phillips et al. (2000b). Seasonal variation has also been described. See Zhang, Z.-M., Cai, J.-J., Ruan, G.-H., and Li, G.-K. (2005). The Study of Fingerprint Characteristics of the Emanations from Human Arm Skin Using the Original Sampling System by SPME-GC/MS. *Journal of Chromatography B*, 822, 244-252 ("emission behavior of human odors in the moist season varied from those taken in the dry season").

¹⁴⁸ Jezierski et al. (unpublished results).

¹⁴⁹ Kuhn and Natsch (2008).

an identification (alerted to the trail layer) or lost the trail. Neither the handler or the researcher following the canine team knew which individual at the end of the trail was the trail layer.

The experience of the dogs was found to correlate with successful results. Novice dogs, with less than 18 months of training, had a 53.3% find rate, with one false identification (picking the partner over the person to whom the dog had been scented). Veteran dogs, on the other hand, had a 96% find rate with no false identifications. Of 20 trails run by veteran dogs, 19 were completed, while only 12 of 20 trails were completed by novice dogs. The weather circumstances were often unfavorable. Prior to the first trails, a storm dropped an inch and a half of rain. After a second set of trails were laid in a regional park, a trout fishing contest took place in the area and at least 1,000 people walked over the previously laid trails before the dogs were asked to follow those trails. The authors argued that the lower success rate for the novice dogs might have been due to their less mature neurological systems.¹⁵⁰ The research confirms the emphasis a great many courts have placed on the experience of a dog in tracking,¹⁵¹ but it is worth emphasizing that even though dogs distinguished trails left by different individuals, tracking and trailing procedures are very different from scent identification procedures.

Another identification experiment involving tracking sought to determine whether dogs could distinguish the tracks of identical twins and other persons who were closely related, as well as individuals who were living together who might or not be related.¹⁵² Monozygotic twins were the most difficult group for the bloodhounds to differentiate. No dogs were able to perform better than chance for twins that lived together. For twins that had lived apart for at least a year, only one dog out of nine performed better than chance. If the test involved related people living together (siblings or parent-child), 10 of 13 dogs performed significantly better than chance. If related pairs did not live together, all 12 bloodhounds used in the test performed better than chance. For non-related people living together, all 13 dogs performed a negative trail significantly better than chance. This was also true of the nine bloodhounds used to trail non-related people living apart. The researchers concluded:

The findings suggest that bloodhounds may use genetically derived odortype as its major source of scent while trailing. The more genetically similar two people are, the more difficult it is for the dogs to tell the difference. The similarities between two people may force the dog to rely on environmental cues for scent discrimination and trailing.

Odortype, according to the researchers, is not solely based on genetics, as environmental cues may affect a dog's performance. The authors observed that their study supported the use of bloodhound evidence in courts because it lent "credibility to the bloodhound's ability to trail and discriminate between various people using genetically derived

¹⁵⁰ Harvey and Harvey (2003) (two youngest dogs in the experiment were 10 and 11 months old but within three months they improved to the level of making their finds 100% of the time). See also, Roberts et al. (2005) (humans found capable of distinguishing scents of twins).

¹⁵¹ See, e.g., *Blair v. Kentucky*, 171 Ky. 319, 188 S.W. 390 (1916), 181 Ky. 218, 204 S.W. 67 (1918); *Bullock v. Kentucky*, 249 Ky. 1, 60 S.W.2d 108 (Ct. App. 1933).

¹⁵² Dogs were trained under the method described for tracking dogs by Tolhurst (1991).

odortype, as well as possible environmental signals.”¹⁵³ Again, this research was not done in the scent lineup setting, and though indicating that the dogs could distinguish scents individuals left on a trail, the trail itself is a reinforcing factor that is not present in a scent lineup.

A research study that involved extracting scent from debris at sites of car bombs and improvised explosive devices staged in the Arizona desert involved trailing from the blast site, or in one experiment, from a roadside device away from the detonation site. Scent was gathered from post-blast debris using a scent transfer unit (STU-100). The success of the dogs in trailing the experimental terrorists could be verified because the targets carried GPS units to document their paths. Thirteen canine-handler teams participated, though not all dogs were used in each segment of the study. Trailing dogs (not tracking dogs) were used, and the dogs followed the trails from three to six hours after the detonations. There were decoys in each experiment, as well as debris gatherers, cameramen, and research observers, many of whom overlaid trails of the “terrorists.” In 33 of 35 trailings (94.3%), the dogs followed a correct trail, but the identification rate was lower. Where the trailing started at the detonation site, 82.2% of the targets were correctly identified. Where the trailing started by a roadside device away from the detonation site was included, the overall identification rate dropped to 73.5%, with two false identifications in the latter instance. The researchers attributed these false identifications to handler error because a review of videotapes suggested the handlers forced the identifications (i.e., cued the dogs).¹⁵⁴

Distinguishing Scent from Different Parts of the Body. Hand scent is of interest forensically since hands often hold weapons, stolen property, items the perpetrator touched but did not or could not move, and so forth.¹⁵⁵ Scent lineups usually involve collecting hand scent samples, often by wiping the suspect’s hand with cotton or having the suspect hold a steel tube. A comparative study of hand scent forensics concluded that hand scent is more stable in the face of illness than scents from some other parts of the body:

Hand odor is a combination of eccrine and sebaceous gland secretions without the involvement of the apocrine gland, which contributes immensely to the malodors generated from the armpit region. Alterations to portions of the odor of an individual may occur due to the influence of illness, the onset of puberty, the menstrual cycle in females, etc. Many of these factors directly affect the apocrine gland. The secretions obtained from the eccrine and sebaceous glands are less likely to be influenced by these changes, thereby more likely to produce the stable odor of an individual.¹⁵⁶

¹⁵³ Harvey et al. (2006).

¹⁵⁴ Curran et al. (2010).

¹⁵⁵ Curran et al. (2006a) (73% of human scent evidence collected in the U.S. comes from contact between objects and the hands of an individual). Tracking dogs are primarily following foot scent, particularly odor of the forefoot. Gerritsen and Haak (2001), 45-48.

¹⁵⁶ Curran et al. (2010).

Eccrine glands are found throughout the body but the highest densities are in the palms and the soles of the feet. These glands can secrete up to two to four liters of fluid each hour, about 98% of which is water. Sebaceous glands are usually located in body regions where hair is present. Sebaceous gland secretions, called sebum, consist of glycerides, free fatty acids, wax esters, squalene, and cholesterol. A person's diet can influence sebum.¹⁵⁷

The uneven distribution of glands in the body raises the issue of whether each individual has distinguishable scents depending on where on the body a scent sample is taken from. If a criminal touches one item with his hand, and another with the back of his arm, will the scent taken from the two items be the same? A study published in 1991 considered whether scent from different parts of the body would be equally identifiable by dogs. The assumption of "folk wisdom," according to the authors of the study, is that the same scent would be found in an individual's shirt, a handkerchief, socks, or a utensil the individual touched while eating. The researchers used three dogs that were trained to retrieve a dumbbell scented by the hand of the handler and placed on a pegboard near an identical but unscented dumbbell, which was wired to the board. The unscented dumbbell had been untouched by humans for at least 24 hours and had been stored on a tray open to the air for that period.¹⁵⁸ Most dogs were highly accurate in telling their handler's hand from a dumbbell with no human scent,¹⁵⁹ but less successful when elbow scent was compared to no human scent. Dogs were generally successful distinguishing between their handler's hand and a stranger's hand, but distinguishing between the handler's elbow and a stranger's hand produced results not statistically different from random. When choosing between the handler's hand and his elbow, dogs chose the hand scent 76.8% of the time, suggesting to the researchers that dogs had inadvertently been trained to identify a hand scent. The researchers concluded:

[T]hese results suggest that there may be an identifiable individual scent in addition to the body-part specific scent, but that without special training, the discrimination of scents from different individuals will succeed only when scents are obtained from the same body part of each subject.

The authors questioned whether dogs should be used to match humans with physical evidence for forensic purposes because many cases would not allow clear determination of whether regionally specific body odors had to be distinguished by the dog.

Particularly open to question, for example, would be the use of a piece of clothing from the upper part of the body (e.g. hat, gloves, shirt) as a reference scent article on the basis of which the dog is expected to select a track of human scent made by

¹⁵⁷ Curran et al. (2005).

¹⁵⁸ The assumption that scent would completely dissipate from lineup articles in 24 hours has not been made by other researchers. Steel tubes, under Dutch procedures for instance, are sterilized between uses in lineups.

¹⁵⁹ Dogs distinguished objects scented by their handler's hand 93% but not 100% of the time from objects with no human scent. It seems implausible that those dogs were not able to sniff out the difference between no human scent and the scent of their handler. An explanation could be that this difference was not always interesting for the dogs, or that the dogs did not associate the handler's scent with the reward or were not sufficiently motivated to earn the reward.

footsteps through the environment. Although it may indeed be possible to train individual dogs to perform such tasks, the results presented here make it clearly incumbent upon the individual dog trainer or handler to demonstrate that his or her dog can indeed perform the required scent identification tasks with an acceptable degree of statistical reliability, before evidence based on the performance of such a dog should be accepted in a court of law.¹⁶⁰

This research was criticized as asking the dogs in the experiment an ambiguous question given that they were trained on hand odors, not elbow odors. The suggestion was made that training involving elbow odors would produce more clear results.¹⁶¹ The authors of the original research replied to this by stating:

We purposely introduced this ambiguity [asking dogs trained to discriminate based on hand odors to do so with odor from a different part of the body] to determine whether trained dogs automatically generalize scents from one part of the body to other body parts, as a strict interpretation of the individual odor theory would suggest. Above all, many law enforcement authorities and courts of law would contend that such a task should not have been ambiguous, because the single individual odour associated with each human subject should have pervaded all scents regardless of the part of the body from which they were derived.¹⁶²

The significance of this research is that dogs may not alert as correctly when the scenting item takes scent from another part of the body than the object in the lineup row took from the various suspects and foils who provided (often hand) scent for the lineup.

Two other researchers also looked at the hand-elbow distinction. They suggested that the inability of dogs to match smells collected from different body parts in the study just described “might well be a matter of training.” The researchers used six police dogs trained in scent identification tasks. The experimental protocol used 10cm stainless steel tubes that were cleaned with soap and boiled in tap water for at least half an hour, and handled with tongs thereafter. People scenting the tubes held them for three minutes and then replaced them in sterilized glass jars with twist-off tops. Most people scenting tubes were male and “suspects” were always male. A dog could choose between six tubes and a match was potentially possible in all trials, with a chance level of 16.7% for each trial. The dogs were 32% correct in the elbow to hand trials, and 32% correct in the hand to elbow trials. They were much better, 58%, in the pocket to hand trials. When the “suspect” was an employee of the Police Dog Training Center where the tests were conducted, the dogs were correct 73% of the time, but correct only 25% of the time when the “suspect” was a complete stranger. The researchers concluded that Dutch police dogs are capable of cross-matching scents collected from different body parts. The higher accuracy on tubes scented in a “suspect’s” pocket may be due to the fact that there is a lot of hand odor in pockets.¹⁶³

¹⁶⁰ Brisbin and Austad (1991).

¹⁶¹ Sommerville et al. (1993). One author here (Jeziarski) notes that the dogs may have made a distinction but not a choice because of the lack of a clear reward.

¹⁶² Brisbin and Austad (1993).

¹⁶³ See Schoon and de Bruin (1994).

Despite better results than the prior study, there must remain some concern as to how an item was handled at the crime scene by the perpetrator when that differs from how scent was imparted to objects used in the lineup. Problems will be reduced by having all items in the lineup scented in the same way, but it appears that this remains a weakness that cannot be fully overcome.

Distinguishing Genders. One study considered whether female scent placed in a sequence of male odors would influence the reliability of the alerts of dogs. The study involved 22 police dogs. Scent was taken from the hands of eight woman participants who held an item for 15 minutes. The women lived in the same dormitory, ate in the same canteen, and took the same classes, and traces taken from them would differ only in individual scent. Complementary material was taken from men. The research concluded that the scent of a woman in a sequence of male scents is not attractive to dogs. When scented to a woman, they did not pick out another woman in a sequence that consisted otherwise of male scents. False positives in such a sequence were random.¹⁶⁴

There is some evidence that the scent of individual women is more easily distinguished by dogs than that of individual men. Analysis of 3,675 trials with lineups consisting of exclusively male scents (2,523 trials) or exclusively female scents (1,152 trials) showed that dogs made significantly more correct choices (66.8%) when they had to find a matching female scent samples than when they had to find matching male scent samples (63.4%). Additionally, the dogs made non-significantly less false alarms towards female scents than towards male scents and significantly less misses in relation to female scents.¹⁶⁵ This may indicate that scent lineups will be more reliable when the target scent is female.

Attractiveness, as a factor resulting in dogs falsely alerting to individuals in lineups, will be discussed further below.¹⁶⁶

Effects of Tertiary Odor

Animal-fat based soaps contain constituents that include compounds reported in humans.¹⁶⁷ One researcher found, nevertheless, that the external component of human odor related to cosmetics does not significantly affect a dog's ability to distinguish individuals. Dogs in the identification study were not confused by a "common" odor component related to the same cosmetics used by the scent donors. The researcher found a very low percentage of false alarms (1.92%) towards people who used the same cosmetics.¹⁶⁸ Other research has indicated that smoking cigarettes by scent donors does not influence the correctness of identifications.¹⁶⁹

Nevertheless, the authors believe that secondary and tertiary factors should be taken into consideration in lineups. The sex of individuals used in the lineup should be the same, age differences of donors and storage time of scent samples should be kept as

¹⁶⁴ Rogowski (2003).

¹⁶⁵ Schoon found no differences based on gender. Schoon (1997a).

¹⁶⁶ Attractiveness has been suspected as a factor in human visual lineups. See Wojcikiewicz et al. (1999); Doob and Kirshenbaum (1973).

¹⁶⁷ Curran et al. (2005a).

¹⁶⁸ Gawkowski (2000).

¹⁶⁹ Schoon (1997a); Misiewicz K., (2000). Influence of nicotine on performance of scent identification dogs. (in Polish). *Problemy Kryminalistyki* 229, 38-40; McCulloch et al. (2006).

low as possible so that scent samples of elderly people should not be tested in the same lineup with the samples from young people, and old samples should not be tested together with fresh samples.

COLLECTING SCENT

Human scent may be collected by four forensic applications:

1. Sampling the object (which can be difficult with small objects).
2. Wipe the object with absorbent material (which might destroy fingerprints or DNA).
3. Head space absorption, in which an absorber is placed in a container with the evidence (usually taking hours to days for a scent transfer).¹⁷⁰
4. Dynamic head space concentration in which the air surrounding a sample object is passed through absorbent cotton gauze or other material to concentrate scent on the absorbent material. This speeds up the process of the previous approach by using airflow.

The first three categories have the disadvantage of possibly disturbing or contaminating trace evidence. The fourth category generally involves use of a scent transfer unit.¹⁷¹

Crime scene items that have been used for scenting dogs used in lineups include clothes,¹⁷² weapons and shell casings,¹⁷³ cigarette filters,¹⁷⁴ plastic bags containing heroin,¹⁷⁵ a footprint at a place where the perpetrator had jumped off a roof,¹⁷⁶ and a handkerchief tied over a victim's mouth with her blood.¹⁷⁷ and

Scent Pads

Cloth and gauze have long been used to swipe items that cannot be moved and that the perpetrator may have touched.¹⁷⁸ Cotton, linen, gauze, and other fabrics absorb odors easily. Scent pads have been used on seats and steering wheels of cars used in crimes.¹⁷⁹ A scent pad can be placed on a car seat with tongs and left there for two hours (absorption). One police dog scenting expert recommends keeping the windows of the

¹⁷⁰ See *Michigan v. Giles*, 2008 WL 2436529 (Ct. App. 2008) (gun put in plastic bag with sterile gauze pad for about five minutes).

¹⁷¹ *Ochoa v. City of Buena Park*, 2008 WL 2003761 (C.D.Cal. 2008); *California v. Barajas*, 2002 WL 1722329 (Ct. App. 2002); *California v. Rivera*, 2004 WL 2601335 (Ct. App. 2004); *California v. DeSantiago*, 2003 WL 21753766 (Ct. App. 2003); *California v. Salcido*, GA052057 (Super. Ct. 2005).

¹⁷² *California v. Robinson*, 2004 WL 2418068 (Ct. App. 2004).

¹⁷³ *California v. Barajas*, 2002 WL 1722329 (Ct. App. 2002).

¹⁷⁴ Kaldenbach (1998), 120.

¹⁷⁵ Kaldenbach (1998), 123.

¹⁷⁶ Kaldenbach (1998), 125 (case thrown out because evidence tampered with unbeknownst to handler).

¹⁷⁷ Kaldenbach (1998), p. 128.

¹⁷⁸ Curran and Furton (2006) (noting it "has been shown that there is a measurable amount of human scent weight still present on gauze up to 84 days after a 15 minute scenting period").

¹⁷⁹ See *California v. Aguilar*, 2004 WL 2051385 (Ct. App. 2004) (scent taken from car seat 15 days after impounding).

car slightly open to keep air circulating in the car. The pad is then returned to the sterile jar and kept until a suspect's odor is tested in a scent lineup.¹⁸⁰

Scent Transfer Units

The fourth method of gathering scent listed above, dynamic head space absorption, has led to judicial controversy over whether the use of specialized equipment for gathering scent must meet a standard for admissibility of scientific evidence. Scent transfer units are often mentioned in recent scent lineup cases as the device by which scent was transferred from a crime scene item to a scent pad.¹⁸¹ The STU-100 is a portable, hand-held vacuum pump pulls air through an inlet and across a sterile, surgical gauze pad (by Johnson & Johnson®), thereby collecting primarily volatile or vaporized scent compounds. Scent transfer units have been described as modified dust busters.¹⁸² Optimal airflow rates have been studied.¹⁸³ The pad is removed after use of the device and usually double packaged in heat-sealed nylon envelopes.

To conduct a scent check with a trailing canine, the handler first acclimates the canine to the available volatiles profiles (scents and odors) at the start location and establishes a baseline for the canine. After harnessing, the handler opens the nylon envelope and places the pad in front of the canine's nose. If a matching odor is present at the trail start, the canine commences to follow the trail. If no matching odor is present, or the level of volatile organic compounds is below the detection capability of the canine, the canine is trained to respond by refusing to trail.¹⁸⁴

A California case stated that by 2005 STUs were being used by 80 law enforcement agencies in 17 states, as well as in the UK. The FBI has used STUs nationally since 2001 as the exclusive means of retrieving scent off evidence.¹⁸⁵ Although scent transfer unit evidence is usually introduced by the prosecution, there have been instances where a suspect was identified who was not prosecuted and defense counsel have sought to introduce such evidence as exonerating.¹⁸⁶ Cases have sometimes held that STU-related evidence should not have been admitted at trial, but affirmed convictions in any case because the error of admitting such evidence was harmless.¹⁸⁷

Cases mention scent transfer units as having been used to take scent from car seats,¹⁸⁸ clothing,¹⁸⁹ shell casings,¹⁹⁰ a beer can,¹⁹¹ a marijuana cigarette,¹⁹² a cap,¹⁹³ and

¹⁸⁰ Kaldenbach (1998), p. 96. One California court accepted obtaining scent from a steering wheel using a paper towel found in the perpetrator's car by the handler, rejecting that this violated the foundational requirement that the trail not be contaminated). *California v. Sanders*, 2009 WL 3682460 (Ct. App. 2009).

¹⁸¹ Scent pads are more often used to wipe crime scene items and capture the scent by simple contact.

¹⁸² See, e.g., *California v. Mitchell*, 110 Cal.App.4th 772, 2 Cal.Rptr.3d 49 (Ct. App. 2003).

¹⁸³ Prada et al. (2007).

¹⁸⁴ Eckenrode et al. (2006).

¹⁸⁵ *California v. Salcido*, GA052057 (Super. Ct. 2005) (testimony of Rex Stockham, Supervisory Special Agent Hazardous Device Examiner, Explosives Unit, FBI Laboratory).

¹⁸⁶ See *California v. Melara*, 2006 WL 164989 (Ct. App. 2006).

¹⁸⁷ See *California v. Willis*, 115 Cal.App.4th 379, 9 Cal.Rptr. 3d 235 (Ct. App. 2004).

¹⁸⁸ *California v. Chavez*, 2004 WL 1173075 (Ct. App. 2004); *California v. Aguilar*, 2004 WL 2051385 (Ct. App. 2004); *California v. Sandoval*, 2002 WL 519848 (Ct. App. 2002).

a bloody knife.¹⁹⁴ One case described an agreement between prosecution and defense counsel under which the prosecution would not attempt to introduce evidence of a scent lineup if the defense would not object to the admission of tracking evidence.¹⁹⁵

A 2003 California case involved use of a scent transfer unit to prepare scent pads from shell casings found at the scene of a street gang murder. Scents were also collected from shirts worn by the suspects, as well as the victim's. Three control pads were made from chairs that detectives in the homicide bureau, but who had not worked the case. The dog, having been given the scent from the shell casings, alerted to the scent taken from the shirt of a suspect the police believed had loaded the casings into the semiautomatic weapon used in the murder. The dog also alerted to scent collected from the victim's shirt, which the prosecution theorized happened as a result of the suspect turning the victim over after he was on the ground. The dog did not alert to scent pads taken from the clothing of any of the other suspects, which was explained as due to the probability that only one individual loaded the shells into the weapon, nor to the pads prepared from the detectives' chairs. The trial court admitted the canine evidence. The appellate court found that scent transfer units had not been discussed in a *published* opinion and said that this was neither a situation of a new device being used to conduct an established type of test, nor of an established device being used to conduct a new type of test, but rather an STU was a "novel device used in furtherance of a new technique." Therefore, the admissibility of evidence obtained by such a device should have been subjected to a hearing to establish scientific acceptance, proof that the witness testifying concerning it was a qualified expert, and correct use of the device.¹⁹⁶ The court noted that other people may have touched the bullets as well as the victim's shirt, and certainly other persons had touched the chairs of the detectives from which other pads were prepared. Although the dog's ability to isolate specific scent on objects containing multiple scents could be regarded as enhancing the value of the evidence, the court did not feel the matter was adequately considered by the trial court. Nevertheless, the court found the admission of the evidence to be harmless error, however, and upheld the convictions.¹⁹⁷

Procedures have been developed using STUs with dogs, which involve presenting a control to establish a negative response to trail from a virgin pad before the dog is scented with a pad scented by an STU from a crime scene item.¹⁹⁸ Forensic researchers have described the STU is a very useful tool,¹⁹⁹ and have noted that DNA profiles have been obtained from expended cartridge casings and bullets,²⁰⁰ making it reasonable that

¹⁸⁹ California v. Aguilar, 2004 WL 2051385 (Ct. App. 2004); California v. DeSantiago, 2003 WL 21753766 (Ct. App. 2003).

¹⁹⁰ California v. Alonzo, 2008 WL 2248628 (Ct. App. 2008); California v. Chavez, 2004 WL 1173075 (Ct. App. 2004).

¹⁹¹ California v. Barajas, 2002 WL 1722329 (Ct. App. 2002).

¹⁹² California v. Hackett, 2003 WL 463976 (Ct. App. 2003).

¹⁹³ California v. Robinson, 2004 WL 2418068 (Ct. App. 2004).

¹⁹⁴ California v. Salcido, GA052057 (Super. Ct. 2005).

¹⁹⁵ California v. Rivera, 2004 WL 2601335 (Ct. App. 2004).

¹⁹⁶ Citing California v. Kelly, 17 Cal.3d 24, 549 P.2d. 1240, 130 Cal.Rptr. 144 (1976).

¹⁹⁷ California v. Mitchell, 110 Cal.App.4th 772, 2 Cal.Rptr.3d 49 (Ct. App. 2003).

¹⁹⁸ Eckenrode et al. (2006).

¹⁹⁹ Stockham et al. (2004), discussing California v. Willis, 115 Cal.App.4th 379, 9 Cal.Rptr. 3d 235 (Ct. App. 2004).

²⁰⁰ See Wickenheiser et al. (2002); Szakacs (2000). See Raymond et al. (2004).

human odor from such items could be extracted with a scent transfer unit.²⁰¹ The length of time after the crime that a pad was prepared by an STU has sometimes been considered by courts.²⁰² The admissibility of evidence relying on the use of a scent transfer unit has been discussed in a number of decisions, particularly in California.²⁰³

Interval before Scent is Collected

One researcher found no difference in identification accuracy as to samples collected after 15, 30, 45, and 60 minutes.²⁰⁴ Other research has indicated that collecting scent from an object after three to five days is sufficient to allow a dog to make a correct identification.²⁰⁵

Effect of Contamination

In Poland, police osmology experts have conducted experiments on the effects on the ability of dogs to identify evidential scent despite contamination by other scents. Contamination of the evidential scent by 10% vinegar did not prevent trained dogs from correctly identifying the perpetrators.²⁰⁶ One researcher concluded that dogs are able to identify each of three persons who touched an object.²⁰⁷

Contamination cannot always be presumed because of contact. One study failed to establish that individual human odor molecules could be transferred from a person to an object indirectly by shaking hands with that other person and the other person then touching an object.²⁰⁸

Storage of Scent Samples

Scent samples from the crime scene must be stored until a suspect is found and there is reason to conduct a lineup, which can happen quickly or take years. A comparison of

²⁰¹ Stockham et al. (2004).

²⁰² California v. Aguilar, 2004 WL 2051385 (Ct. App. 2004) (possibly 41 days); California v. Alonzo, 2008 WL 2248628 (Ct. App. 2008) (10 months); U.S. v. McNiece, 558 F.Supp. 612 (E.D.N.Y. 1983) (21 months). Scent samples from carefully preserved crime scene items have been used in European cases years after the crime. Rogowski (2001).

²⁰³ See California v. Melara, 2006 WL 164989 (Ct. App. 2006) (trial court properly excluded exonerating evidence because of lack of proper foundation); California v. Alonzo, 2008 WL 2248628 (Ct. App. 2008) (lack of negative response test went to weight but not admissibility of evidence); California v. Craig, 86 Cal.App.3d 905, 150 Cal.Rptr. 676 (Ct. App. 1978) (“The scent transfer unit is simply a device used to implement the obvious principle that scent travels in air. There is no novel scientific principle behind the use of suction to move air and the scent contained in it; it is the same principle at work in air filters in every home. *Kelly/Frye* does not require a foundational hearing on this principle in order to support the admission of testimony involving the use of the scent transfer unit.”); California v. DeSantiago, 2003 WL 21753766 (Ct. App. 2003) (remand for hearing on scientific validity of STU); California v. Mitchell, 110 Cal.App.4th 772, 2 Cal.Rptr.3d 49 (Ct. App. 2003) (court was troubled that scent pads may have been prepared from items touched by individuals besides the defendant); California v. Willis, 115 Cal.App.4th 379, 9 Cal.Rptr. 3d 235 (Ct. App. 2004) (holding that it was “not obvious that a vacuum device can properly transfer scent to a gauze pad form an object” though other evidence was sufficient for jury to reach guilty verdict and error of admitting STU evidence was harmless); California v. Salcido, GA052057 (Super. Ct. 2005) (STU evidence admissible with corroboration).

²⁰⁴ Rogowski (2001a).

²⁰⁵ Rogowski (2001a); Zdanowicz and Kaminski (1998).

²⁰⁶ Dudek and Srebnik (2000).

²⁰⁷ Rogowski (2005).

²⁰⁸ Rogowski (2006).

storage containers including glass, polyethylene, and aluminized pouches concluded that glass containers subject to minimal light exposure provide the most stable environment for stored human scent samples. The problem with polymer and aluminized materials is that a significant amount of compounds are transferred to the cotton material. This conforms to the common practice of Western European countries. China has begun storing scent samples at -18°C .²⁰⁹ A medical research team is storing scent samples at -40°C .²¹⁰

Aging of Crime Scene Items

Studies have shown that the length of time between when a crime scent item was contacted by a perpetrator and when the lineup occurs is likely to affect a dog's accuracy. Three researchers at Duke University lightly fingerprinted 1 by 3-inch glass slides, preparing one slide from each person for indoor storage and one for outdoor weathering. Indoor slides were stored in a cabinet. Outdoor slides were put in flat boxes and put on the laboratory roof. Environmental conditions were recorded. At 6, 12, 24, 48, 72, and 96 hours and at 1, 2, and 3 weeks trays of equal age were taken from the cabinet and the roof. The same two dogs were used for trials. Slides were put in circles of five, four of which were blank for each trial. At the end of three weeks, each dog could still detect indoor fingerprinted samples easily. By eight weeks, performance was at chance levels (20% success). The researchers found that slides exposed on dull, rainless, days tended to be found more readily than slides exposed to the bright sun, but most weather data provided little correlation to results.²¹¹

In an experiment designed to determine how aging of crime scene odors affects a dog's ability to match such an odor to a scent in a lineup, odors were collected by individuals handling metal or plastic tubes for a short while or putting cloth in their pockets for ten minutes. In the trials, materials of the same sort as the scenting item were placed in glass jars in a circle, one of which, after a zero trial, contained the scent of the target while the others contained scents of foils. The trials were performed immediately after scenting all the items (time zero), then at 2, 4, 8, 12, 16, 20, and 24 weeks. Ten dogs were perfect at time zero, but recognition declined significantly thereafter. Dogs performed most poorly with plastic piping, though the type of material did not produce large differences overall. The author, noting that scent discrimination has been displayed in some studies with scents up to seven years old,²¹² suggested that freezing the "crime scene item," or storing it at low temperatures might prevent the drop in performance, as is sometimes done in the United States. This study indicates, however, that lineups occurring within days of the crime are more likely to be highly accurate.²¹³

Transfer of Scent Through Clothes

Scenting techniques have sometimes been used to determine whether a suspect was sitting in a car, and which seat he sat in.²¹⁴ A researcher in Warsaw has looked at some of

²⁰⁹ Hudson et al. (2009).

²¹⁰ McCulloch et al. (2009).

²¹¹ King et al. (1964).

²¹² Schoon (2003).

²¹³ Id.

²¹⁴ California v. Sandoval, 2002 WL 519848 (Ct. App. 2002).

the issues that arise with regard to scent transfers through clothing and found that if individual A puts on pants belonging to individual B and sits in a car belonging to individual D for an hour, three dogs could match the scent of B from the car to a comparative sample made by B. Thus B's scent transferred to the seat of the car even though B did not sit in the car. The same was not true of gloves of C which were worn by B when he sat in the car. That is, two dogs failed to alert to a comparative sample made by C. Yet another two dogs did alert to a comparative sample made by A when scented to trace from the seat of the car. Thus, A's scent was on the seat though he did not touch it other than to wear B's pants while sitting in the car. On the other hand, two other dogs, when scented to trace from the steering wheel, did not alert to the comparative sample of B, who had been wearing the gloves of C. Thus, B's scent apparently did not go through the gloves, though his scent had gone through the pants.

The researcher concluded that a scent trace from a carrier may contain the individual scent of a person who has not had direct contact with it. Factors that could determine what a dog would alert to include:

- Duration of use of garment by owner.
- Duration of contact of garment with scent carriers.
- Surface of contact between the garment and the scent carrier.
- Elapsed time from when the scent trace originated to when it was secured.
- Rise in temperature at point of contact of garment with the carrier.

The researcher noted that individual scents of different people on an item producing a scent trace did not cancel each other out or create some new, different scent.²¹⁵ In an experiment following a similar design, the same researcher concluded that human scent does not pass through rubber gloves in 20 minutes in an amount exceeding the olfactory threshold of scent identification dogs.²¹⁶

Identifying Where Suspects Sat in a Vehicle

Cases have described police as being able to define which seats in a car suspect were sitting in during or around the time of a crime.²¹⁷ There may be a limited window as to how long the parties sat in a car. One researcher found that if two people sat in a car for 30 minutes and the scent samples were taken from the seats after no longer than 60 minutes, it could be determined in a scent lineup which seat was occupied by the suspect. When the time from when the passengers left the car to when scent samples were collected was more than an hour, the identification could not be made. It did not matter if the passengers were wearing the same perfume.²¹⁸

Length of the Sniff

²¹⁵ Rogowski (2002).

²¹⁶ Rogowski, (2004). See Romanes (1887) (handler's dog followed boots of handler even when worn by stranger, but did not follow boots of stranger when worn by handler; nor did he follow new boots worn by handler).

²¹⁷ California v. Chavez, 2004 WL 1173075 (Ct. App. 2004); California v. Aguilar, 2004 WL 2051385 (Ct. App. 2004); California v. Sandoval, 2002 WL 519848 (Ct. App. 2002).

²¹⁸ Gawkowski (2001).

Studies on tracking direction indicate that dogs only need a few seconds to determine the direction in which an individual is walking, and only need five footsteps to do so.²¹⁹ Scenting dogs on items or scent pads for a scent lineup is usually restricted to a few seconds in experiments and in actual lineups.

Scent Matching Materials

When identical items are put in a lineup, distinguished only by having been handled by different people, police practice varies from country to country as to which material is best for such a test. This also has been the subject of research. One study found that in the particular testing system used, dogs were more accurate at matching scents to scents on steel tubes than to scents of cloths in jars, with 85% accuracy in the former and 80% accuracy in the latter.²²⁰ Also, training dogs using steel tubes took less time than using glass jars. The researchers noted that some dogs clearly had more aptitude for this kind of work than others. They thought it likely that with appropriate training, many breeds of dogs selected for tracking and retrieval could achieve high and dependable success rates.

However, variations do occur in the individual aptitude of dogs and even a good dog may sometimes perform badly, so it is essential to subject each dog to several trials when a suspect is being identified. If this is done, selected dogs should provide a valuable resource in criminal investigation and security operations.²²¹

The authors agree and believe that U.S. courts have too readily accepted scent lineups in which dogs performed only one trial, with controls seldom mentioned or performed.

Selecting Foils

In a lineup, a dog has to select from a row of scent samples, usually obtained from different people. The suspect is usually but not always one of the samples, but the others are “foils,” different people often with characteristics similar to those of the suspect to the extent such characteristics can be identified. One detective described how money that had been taken from a victim in a robbery had to be used to identify the suspect. Since the woman had touched the money, other women were used to scent tubes for the lineup. It was learned the woman was menstruating, so an officer went through the halls of the headquarters announcing that he needed such a person. A volunteer came forward so that at least one of the foils would also be a menstruating woman.²²²

Number of Stations in Lineup

The number of stations in a lineup varies in both research and police practice, generally being from five to seven. It can be said that the higher number of stations and the lower

²¹⁹ Thesen et al. (1993); Hepper and Wells (2005). Recent research indicates that the dogs nostrils draw in separate odor samples, aiding in the determination of direction. Craven et al. (2010).

²²⁰ Steel tubes have the advantage of being both objects to sniff and rewards because dogs can play with them. Some dogs, however, are reluctant to retrieve hard metallic objects. Steel tubes cannot be used a second time after retrieval because the dog’s saliva is left on the tube, which may be a cue for the dog during the next search. Cloths are placed in jars which prevent the dog from touching them and they do not need to be replaced during a series of trials.

²²¹ Settle et al. (1994).

²²² Kaldenbach (1998), p. 147.

number of targets in the lineup, the lower probability that a dog will indicate correctly by chance. In the canine identification procedure applied by Polish police the most typical is a scent lineup of five stations out of which one is the target station.²²³ In the Netherlands, police usually two parallel scent lineups of six or seven stations.²²⁴ It is important that the dog sniff all stations in the lineup since omitting some stations increases the probability that the sample has been indicated correctly by chance.²²⁵

Scent Attractiveness

Results of a lineup may be less accurate if dogs sometimes select matching items because of some attraction to the odor on them, rather than because of a match to the scenting item. Schoon and de Bruin found that dogs were much more often correct when alerting to a “suspect” they knew than one not known to them.²²⁶ This may not only be familiarity, however. The scent of particular persons may be attractive to particular dogs, which means that dogs may tend to make false positive identifications of certain persons, which is a particular reason for using decoys in control trials. If a control’s scent is alerted to by the dogs incorrectly in controls, it can be assumed that this particular person is “attractive” to the dog and reliable identification in an evidential lineup becomes impossible.

It has been suggested that a dog might be attracted to a scent because it is different from other odors in a lineup, and that this is one reason why differences between scent providers for a lineup should be minimized. Thus, people providing scent should be of the same sex,²²⁷ similar racial background, and wash their hands with non-perfumed soap prior to scenting tubes or cloths.²²⁸ The phenomenon of attractiveness has been observed in a study of scent lineups in which dogs were trained to identify individual tigers from scat.²²⁹

Attractiveness has been measured by the number of false alerts towards decoys in experimental lineups. In a study using scent of 186 persons, only 19.3% of persons examined had a “non-attractive” scent to the dogs (0% of false alerts). The majority of persons (76.3%) had a scent that was of low attractiveness to the dogs (>0 to 25% of false alerts) and only 1.1% of persons were of higher attractiveness to the dogs (50-75% of false alerts).²³⁰ It is not clear that this attraction will always be apparent during the

²²³ Gawkowski (2000).

²²⁴ Schoon 1996); Schoon .A.A., (1998); Schoon (1997) (suggesting new paradigm that has not been adopted).

²²⁵ Jezierski et al. (2003).

²²⁶ Schoon and de Bruin (1994) (dogs responded correctly in 75% of trials towards scent samples of people who were well known to the dogs, there were 67% correct responses towards people whose scents were frequently used in tests, and only 25% of correct indications of people who were completely unknown to the dogs; results were obtained using only 3 dogs, so, no valid conclusion can be drawn.). See Robinson v. Texas, 2006 WL 3438076 (Ct. App. 2006), 2009 WL 5205361 (Ct. App. 2009) (two dogs alerted to scent of suspect but one dog had sniffed only half of cans in lineup).

²²⁷ As noted previously, one study found that female scent was not in and of itself attractive to dogs. Rogowski (2003).

²²⁸ Schoon (1998).

²²⁹ Kerley and Salkina (2007).

²³⁰ Jezierski et al. (2003).

control trials.²³¹ Thus, attractiveness could sometimes be difficult to distinguish from an alert that is false for other reasons.

What makes the scent of a person more “attractive” to the dogs is not clear, although one researcher argued that the “scent attractiveness” may be related to the interference of the scent memory which cause that some scent are perceived by dogs as “pleasant” or “unpleasant.”²³² Odor samples were taken from the vulva of a female dog during heat, placed in one stand in the lineup amidst human scents, did not result in false alerts towards this scent, but the attractiveness of the odor was demonstrated by a much longer sniffing duration.²³³ Curiously, the longer a dog sniffs, research has indicated that it is less likely to give a correct response. This could mean that when a dog searches too long, it could forget the scent it was supposed to match.²³⁴

IV. TRAINING SCENT IDENTIFICATION DOGS AND PROTOCOLS FOR SCENT IDENTIFICATIONS

Dogs used in scent identification lineups in the United States have often been trained in tracking, trailing, narcotics detection, and perhaps general police dog work. In the Netherlands, Poland, Germany, and other European countries, dogs have been specifically trained for scent identification procedures and sometimes may work in no other capacity. Recently the FBI has begun to train dogs according to European procedures and it can be expected, or at least hoped, that some larger U.S. law enforcement agencies will have dogs devoted primarily if not exclusively to scent identification work.

DUTCH TRAINING AND PROTOCOLS

Procedures of the Canine Unit of the Netherlands National Police force are described in several places.²³⁵ Odors in scent lineups are put on stainless steel tubes 10 cm long and 2x2 cm wide. Between trials, tubes are washed in a dishwasher at the highest temperature for an hour. A tube is scented by asking the suspect or foil to open a jar, take a tube out, and hold it for about a minute. The person then returns the tube to the jar and closes the lid. The jar is air-tight. Participants who touch the tubes all wash their hands with the same soap and dry their hands with the same type of clean towel.²³⁶ Tubes are placed on wooded platforms coated with a non-slip surface. Platforms are 5.5 m by 1 m, and steel plates in the middle are designed to hold the tubes. Tubes can be released by a mechanism underneath the platform controlled by a switchbox. Each testing room has two platforms. The six-step training regimen used in the Netherlands is described in the table below.²³⁷ When being moved to a new step, dogs may not perform well and some

²³¹ Schoon explained a dog’s disqualification in one set of trials as due to the “interest” the dog had in the suspect. Schoon (2001).

²³² Gawkowski (2001).

²³³ Jezierski (2002).

²³⁴ Jezierski et al. (2008).

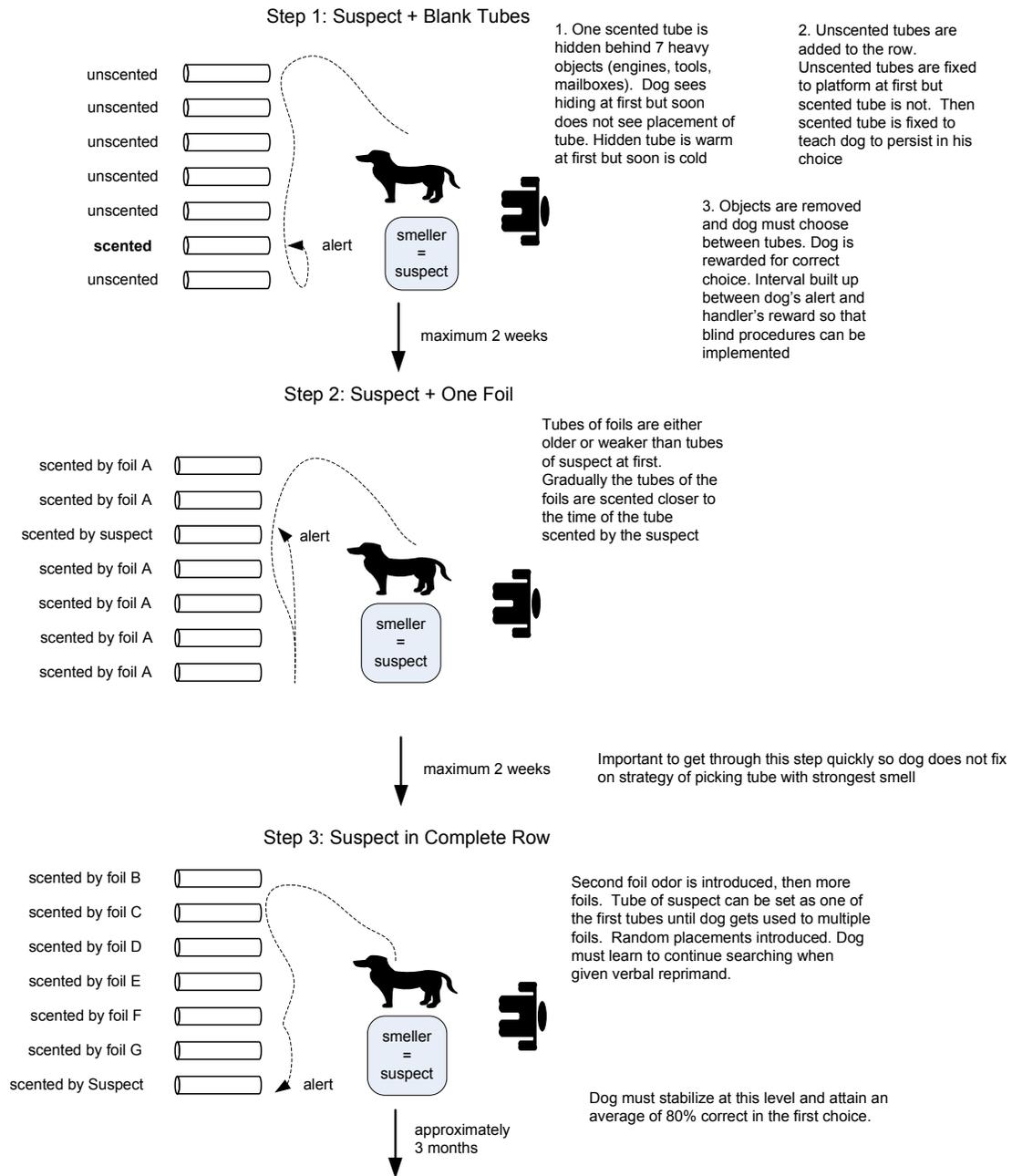
²³⁵ Schoon (2001); Schoon and Haak (2002).

²³⁶ Kaldenbach (1998), 99-100. Kaldenbach summarizes his procedures into nine phases.

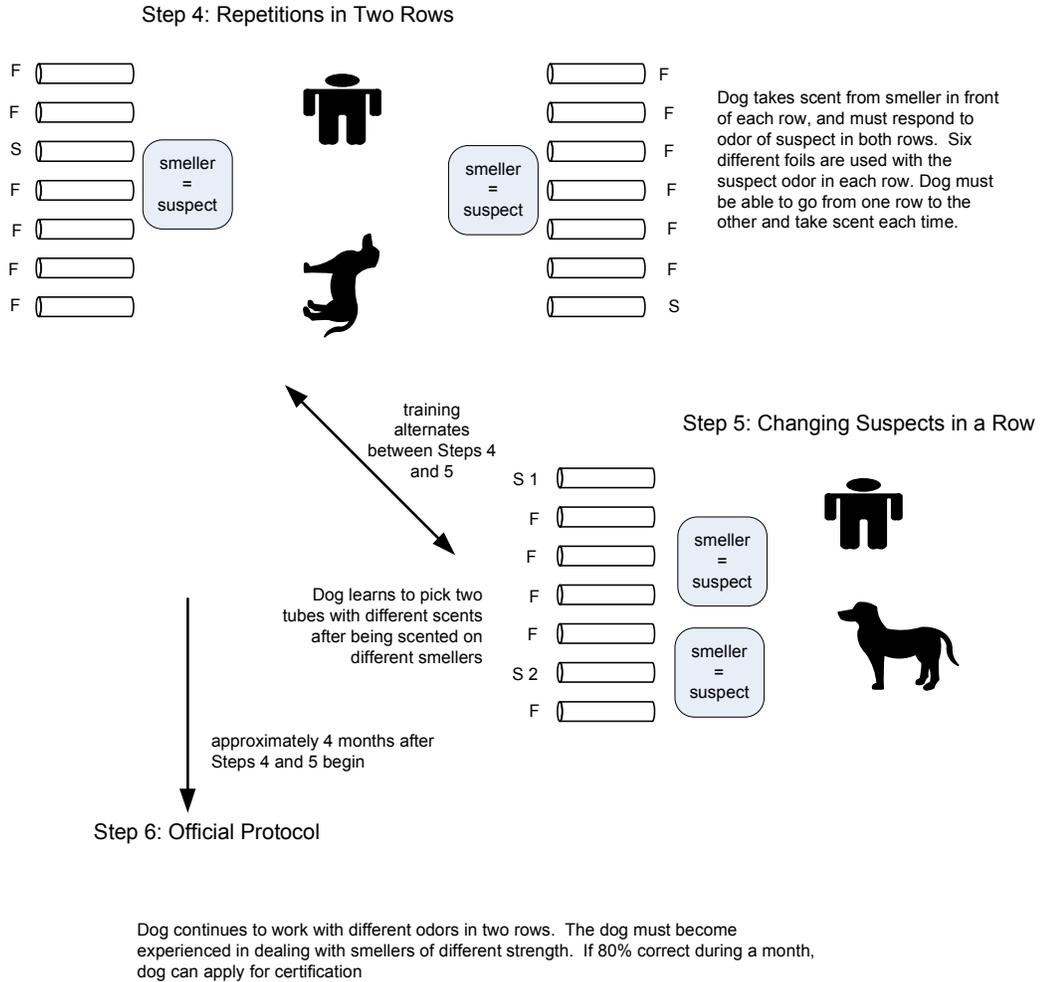
²³⁷ Kaldenbach (1998), 97, describes a similar training regiment taking at least eight months. He specifies that training begins with the dog on a leash.

allowance must be made to simplify the task or move back to a prior step for a brief time.²³⁸ See Figure 4.

Figure 4. Dutch Training Procedures (per Schoon and Haak 2001)



²³⁸ Kaldenbach (1998), 99-100. Kaldenbach summarizes his procedures into nine phases.



The official protocol used by dogs that have been trained is a five-step procedure depicted in Figure 5.²³⁹

²³⁹ Kaldenbach (1998), 93, describing similar procedures, says that the same dog may not do a discrimination for the same suspect within 14 days. This, according to Kaldenbach, gives the dog enough time to ‘forget’ the odor. He also says that the dog may not be rewarded in any way during the procedures. In Schoon’s description, the dog is rewarded if it alerts to the correct tube by the release of the tube and a short period to play with the tube.

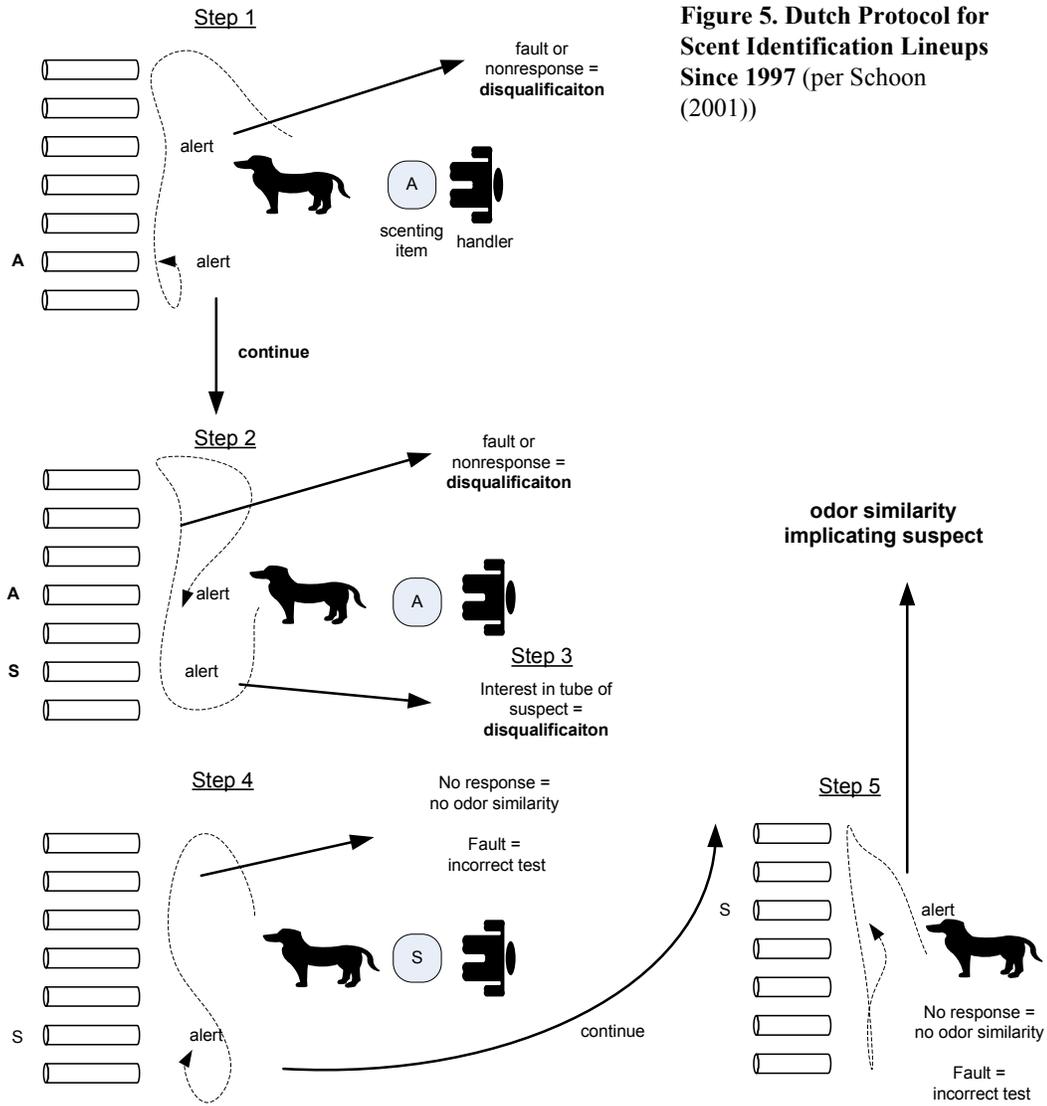


Figure 5. Dutch Protocol for Scent Identification Lineups Since 1997 (per Schoon (2001))

Data from dogs trained under this regimen, along with other dogs trained in similar regimens indicated that dogs identified the correct person who touched an object between 60% and 90% of the time. Dogs used for the statistics alerted to no tube between 9% and 35% of the time. This was a false negative: a correct choice could have been made but in fact no choice was made. Finally, dogs pointed to foils between 1% and 5% of the time. This was a false positive: a correct choice could have been made but an incorrect choice was made.

Similarly, using data from the same sources, where the scenting item was not touched by anyone who touched a lineup tube, but one of the lineup tubes was touched by a suspect, dogs identified the suspect between 0.5% and 4% of the time, but chose no one between 75% and 97% of the time. The latter was the correct response.²⁴⁰ However, dogs alerted to a foil between 2.5% and 20% of the time. This also was incorrect. It was argued that these error rates are sufficiently low that canine scent identification can be considered as more accurate than a number of widely received evidentiary techniques, including paint analysis, glass analysis, fiber analysis, and hair analysis (not DNA).

In analyzing data from actual cases, Schoon noted that only 3.5% of dogs were disqualified in control trials in the protocol, meaning that certified dogs alerted correctly in 96.5% in control trials. When asked to compare scent samples from crime scenes with scent samples of suspects and foils, the dogs alerted in 43% of cases. She found that false negatives occurred in about 6.8% of these actual results, and thereby concluded that false positives could be expected to have occurred with 1.1% of the alerts. Schoon concluded that scent lineups are now “a useful tool in criminal investigation and evidence collection.”²⁴¹

TRAINING PROCEDURES IN POLAND

In the late 1990s, Poland had as many as 117 certified police scent dogs, performing from 1,600 to 1,800 scent procedures annually.²⁴² The training method conducted at the Department of Animal Behavior of the Institute of Genetics and Animal Breeding of the Polish Academy of Science involves giving each dog eight to ten trials a day, depending on the dog’s interest, motivation, and stamina for the work, as determined by the handler. There are three to four training days per week.

The trials take place in a “sniffing room” in an arrangement where an experimenter is invisible to the dog and the handler, observing them through a video monitor. The stands in the lineup are heavy pots holding glass jars with scent samples, the pots being approximately 80 cm apart. Stands can be in a straight line, an arc, or a circle. The training phases leading to a dog’s ability to work scent lineups are depicted below.

In all training phases, two kinds of trials are conducted. Most trials were “active” in which a randomly chosen stand contained a target sample with a scent matching the scent the dog was given at the starting position. Dogs in such trials were supposed to alert to the target sample. There were also, however, “zero” trials in which only blank samples or decoys were placed in the lineup, meaning that the dog should not give an alert since there was no target. Such zero trials were sometimes discouraging to the dogs

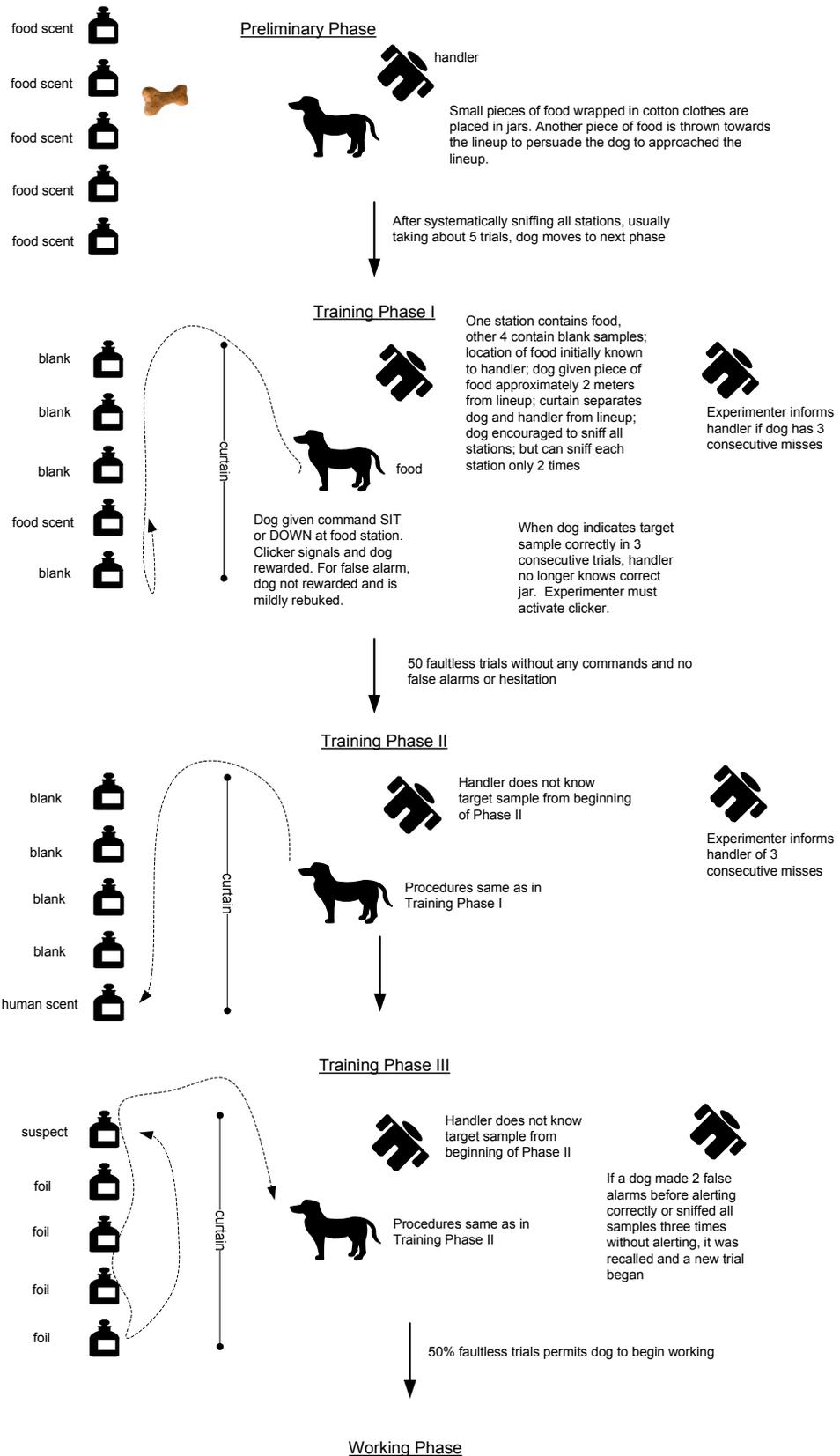
²⁴⁰ Negative controls are also now emphasized in U.S. scent lineup practice. Stockham et al. (2004).

²⁴¹ Schoon (2001), at 182.

²⁴² Jezierski (personal communication).

and were avoided at the beginning of a training day when dogs were less willing to work. After the dog was able to alert spontaneously without commands, the handler did not know whether a trial was an active trial or a zero trial. See Figure 6.

Figure 6. Training Procedures for Scent Lineup Training in Poland (per Jezierski (2008))



USE OF DUTCH METHODS BY THE FBI

Dutch training methods and protocols have been adapted by the U.S. Federal Bureau of Investigation.²⁴³ Three authors, one of whom is with the FBI, describe a number of best practices for scent identification procedures and state the importance of 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.

These authors also state that positive responses should be verified by at least one other canine team.²⁴⁴ All verifications should be blind. A second scent article is recommended, if available. The chain of custody of scent evidence must be maintained, and if used with multiple dogs, each dog should be listed on the chain-of-custody form. Evidence storage documentation must also be maintained, and based on previously discussed research, this should also include data on temperature conditions.²⁴⁵

INDUSTRY GUIDELINES

The Scientific Working Group on Dog and Orthological detector Guidelines (SWGDOG) has issued guidelines for scent identification lineups.²⁴⁶ SWGDOG is one of a number of scientific working groups that attempt to improve discipline practices and build consensus with law enforcement agencies regarding various evidentiary tools. For instance, SWGSTAIN looks at bloodstain pattern analysis. Members of SWGDOG include individuals from a number of federal agencies (including the Drug Enforcement Administration, The FBI, FEMA, ATF), academic institutions (Florida International University, Auburn), police departments, and foreign law enforcement agencies).

This organization specifies that maintenance training should involve at least 16 hours a month. Training records are to include the name of the handler and the dog, the names of those assisting, and the time, date, location, and environmental conditions. The records should also specify if an exercise was non-blind or blind, and who was blind in each trial. Names or descriptions of individuals contributing scents to the lineup are to be recorded. The article used for pre-scenting is to be described, how it was stored, and the duration of contact with the individual providing the scent. Results are to be described, along with any deficiencies or corrective measures implemented. Odor recognition assessments involve dogs making four runs on two scent lineups. Each run is an attempt to match an odor sample to a matching lineup odor. The dog is pre-scented on the odor

²⁴³ Hargreaves (1996).

²⁴⁴ This is preferable to using the same dog twice as the dog may show an attraction to a particular scent.

²⁴⁵ Stockham, et al. (2004).

²⁴⁶ SWGDOG SC 9—Human Scent Dogs: Scent Identification Lineups, issued for public comment until March 19, 2010 (posted at www.swgdog.org).

sample and then expected to indicate the matching target odor in an array of different distractor odors. Odors from 12 different people are collected prior to the assessment. Pre-scenting material is collected from four different human targets. At least four different kinds of objects are used for pre-scenting, which can include screwdrivers, crowbars, hammers, gloves, caps, etc. “If pre-scenting is done on an object that has been in direct contact with a person, this object shall not be identical to the material used in the lineup.” Objects are to vary in duration of contact time with the human target. Thus, a screwdriver might be handled for three minutes, gloves kept in a pocket for a day, a cap worn for an hour. The pre-scenting material is to be prepared directly after, or at least 24 hours before, the preparation of the lineup odors in order to prevent transfer of the object material odor onto the lineup odors. Two six-position lineups of odors from the 12 different people are to be prepared prior to the assessment. The handler describes the dog’s alert prior to the test. The handler does not know the position of the matching lineup odor in any run. A successful outcome involves the dog alerting to the matching lineup odor only. The handler is informed of a successful outcome and can then reward the dog. The dog must perform correctly in 75% of the runs.²⁴⁷ The time frame must be limited, but this can be in accordance with the protocols of the agency

Certification is valid for one year and is dependent on the dog’s passing a comprehensive assessment, somewhat more complicated than the odor recognition assessment described above. A double-blind assessment may also be required in which no one in the room with the dog during the lineup procedure may know where the target sample is located. Certification records include the certifying authority, the names of the individuals awarding certification, and a description of the certification tests. Digital records are preferred in general. Records are presumed to be discoverable by court proceedings and may be evidence of the team’s reliability.

The authors believe that such recordkeeping procedures should apply to all canine teams used in law enforcement and should be required of teams that might produce lineup results for court proceedings.²⁴⁸

SUCCESS RATES OF SCENT LINEUP PROCEDURES

Many studies have found accuracy rates of around 80% to 85%, substantially better than chance but disturbingly low as a possible threshold for the admissibility of evidence from a forensic technique.²⁴⁹ For training and control purposes, 80% is often used as a threshold requirement before a dog can move to another stage. As previously noted,

²⁴⁷ It is not clear why 75% was chosen, given the European preference for 80%, and the fact that research designs often require higher thresholds for controls.

²⁴⁸ Regulations for conduct of scent lineups in Germany, Poland, and the Netherlands, are translated in an appendix to Schoon and Haak (2002).

²⁴⁹ See, e.g., Harvey and Harvey (2003) (96% find rate in trailing tests for experienced dogs, but 53.3% for novice dogs); Harvey et al. (2006) (dogs performed better than chance in distinguishing trails of individuals related or living together provided the relationship was not that of identical twins); Schoon (2003) (dogs 100% correct in matching item touched immediately before test to station in lineup, but accuracy declined significantly even in two weeks); Settle et al. (1994) (85% matching rate with lineup involving steel tubes, 80% with cloth); Curran et al. (2010) (82.2% correct identification of targets after trailing from detonation sites of car bombs and improvised explosive devices; dogs only alerted to decoys twice, correctly identifying 25 targets, so most errors were misses).

however, Dutch research suggested that 96.5% of dogs alerted correctly in control trials, and 3.5% alerted incorrectly and could not be used in actual trials.²⁵⁰

In 1999, a professor at the Jagiellonian University & Institute of Forensic Research in Krakow, Poland, discussed the inconclusive nature of the limited research about scent lineups. The ratio of hits to false alarms has ranged from 4.3 to 6.9, but other common forensic identification methods can be as low as 3 or as high as 160.²⁵¹ As will be discussed below, this ratio (sometimes called the diagnostic ratio or diagnostic ratio of positive results), has been made higher than 10 by the introduction of control trials and the use of protocols with two or more dogs. One study concluded that dogs were more likely to have false positives than false negatives, and that despite precise training procedures requiring that dogs have large number of correct alerts to move to further stages of training, false alerts remained above 20% for some dogs.²⁵²

Designing Protocols to Optimize Accuracy Rates

To reach a sufficient level of forensic reliability to justify the admission of scent lineup evidence in criminal prosecutions, the effort must be to conduct lineups in such a way as to keep errors of individual dogs to a minimum. One way is to provide for trials that eliminate dogs that are not working well on a particular day and to check for the possibility of attractiveness to a particular scent. Another is to increase the number of dogs. Both approaches have been used, often in conjunction, and can be shown to reduce error rates to a level to bring scent lineup evidence within the accuracy rates of some other accepted forensic techniques used as evidence.

Use of control trials to improve the reliability of real trials has been argued by Schoon. The following table demonstrates the combination of real and zero trials.²⁵³ Her research indicated that zero trials (in Protocol 2 in the table below) resulted in an increase in the percentage of false positive alerts and a decrease in correct alerts in actual trials compared to Protocol 1. Adding a control trial and disqualification for failure to indicate a control in Protocol 3 reduced the percentage of false positive alerts in actual trials almost by half and increased the percentage of correct alerts. Introducing two control trials in which dogs have to identify the same control scent in two lineups and are disqualified for failure to do so in even one trial in Protocol 4 was very effective in decreasing the false alerts in actual trials down to only 1.2%. Protocol 5, using two control trials and two control scents to be matched resulted in increasing the number of disqualifications and the percentage of false alerts. Adding layers of control and zero trials reduced the number of dogs that could perform actual trials. Unless there are many dogs, it may be that none will avoid disqualification.

This research also indicated that using steal tubes, as opposed to cloth, gave both a higher percentage of correct alerts, but also a higher percentage of false positives. Cloth produced a higher percentage of misses. See Figure 7.

Figure 7. Analysis of Protocols (per Schoon 2002)

²⁵⁰ Schoon and Haak (2002).

²⁵¹ Wojcikiewicz (1999).

²⁵² Jezierski et al. (2008). For an analysis of how scent lineups are accepted by Polish courts, see Wojcikiewicz (1999).

²⁵³ Schoon (2002).

Protocol (statistics gathered from italicized lineup)	Steel tubes, to be retrieved by dog			Cloth, dog to lie down to alert		
	% correct	% miss	% false	% correct	% miss	% false
<u>Protocol 1</u> <i>Lineup 1: suspect + 5 decoys/</i> <i>Lineup 2: suspect + 5 decoys</i> ²⁵⁴	49.6	8.2	44.9	18.5	48.2	33.3
<u>Protocol 2</u> <i>Lineup 1: suspect + 5 decoys</i> <i>Lineup 2: 6 decoys (zero trial)</i> ²⁵⁵	31.2	8.4	60.4	14.8	40.8	44.4
<u>Protocol 3</u> <i>Lineup 1: control scent + suspect + 5 decoys</i> <i>Lineup 2: suspect + 5 decoys</i>	57.9	21.0	21.1	41.7	41.6	16.7
<u>Protocol 4</u> <i>Lineup 1: control scent + suspect + 5 decoys</i> <i>Lineup 2: control scent + suspect + 5 decoys</i> ²⁵⁶ <i>Lineup 3: suspect + 5 decoys</i> <i>Lineup 4: suspect + 5 decoys</i>				92.0	6.8	1.2
<u>Protocol 5</u> <i>Lineup 1: control scent A + control scent B + suspect + 5 decoys</i> ²⁵⁷ <i>Lineup 2: control scent B + suspect + 5 decoys</i> <i>Lineup 3: 6 decoys (zero trial)</i> <i>Lineup 4: suspect</i>				79.9	9.5	10.7

²⁵⁴ Order of lineups 1 and 2 varied.

²⁵⁵ Order of lineups 1 and 2 varied.

²⁵⁶ 11% disqualified due to no identification of control scent in lineups 1 and 2

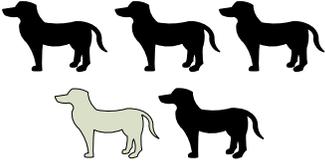
²⁵⁷ 25.6% disqualified due to no identification of control scent A and B.

+ 5 decoys						
Protocol 6 Lineup 1: control scent + suspect + 6 decoys Lineup 2: 6 decoys (zero trial) ²⁵⁸ Lineup 3: suspect + 6 decoys				83.7	0	16.3

As yet unpublished research of one of the authors of this article (Jeziarski) has demonstrated that protocols requiring more than one dog can substantially reduce false positives. The following table demonstrates the procedures that were used and the results obtained. The trials were conducted under Polish lineup procedures discussed above. The protocols differed by two conditions. The first condition was the minimum number of dogs that had to pass control trials for results to be included. If the minimum number of dogs passed control trials, all dogs had to indicate positively. The second condition was the number of dogs that had to indicate positively when more than the minimum number of dogs passed the control trials. If the threshold of dogs making the alert to those not making the alert was not met, the results were considered inconclusive. See Figure 8.

²⁵⁸ 19.4% disqualified due to no identification of control scent and alert in zero trial.

Figure 8. Multiple Dog Protocols With Diagnostic Ratios (per Jezierski, unpublished)

	Protocol Description (3 to 4 control trials and one zero trial preceded identification trials; to qualify, a dog must indicate positively for each protocol; lineups consisted of five stations)	Alerts in Identification Trials	Diagnostic Ratio (correct / false positives)
A	 At least 1 dog must pass control/zero trials; if more than 1 dog qualifies, positive identification requires 1 dog more must alert positively;	<i>Depiction: 1 dog qualifies; dog must alert positively for correct identification</i> <u>Correct</u> <u>False Positives</u> <u>Inconclusive</u> 47% 8.8% 44.2%	47/8.8 = 5.3
B	 At least 2 dogs must pass control/zero trials; if minimum dogs qualify, positive identification requires at least 1 dog more must alert positively; thus if 3 dogs qualify, 2 must alert correctly; if 4 dogs qualify, 3 must alert correctly; if 5 qualify, 3 must alert positively.	<i>Depiction: 3 dogs qualify, at least 2 must alert positively</i> <u>Correct</u> <u>False Positives</u> <u>Inconclusive</u> 38.2% 5.9% 55.9%	38.2/5.9 = 6.5
C	 At least 2 dogs must pass control/zero trials; if minimum dogs qualify, positive identification requires 2 dogs more must alert positively; if 2 dogs qualify, both must alert positively; if 3 dogs qualify, 3 must alert positively; if 6 dogs qualify, 4 must alert positively; etc.	<i>Depiction: 4 dogs qualify, at least 3 must alert positively</i> <u>Correct</u> <u>False Positives</u> <u>Inconclusive</u> 35.3% 2.9% 61.8%	35.3/2.9 = 12.2
D	 At least 3 dogs must pass control/zero trials; if minimum dogs qualify, positive identification requires 3 dogs more must alert positively; if 3 dogs qualify, all 3 must alert positively; if 5 dogs qualify, 4 must alert positively, etc.	<i>Depiction: 5 dogs qualify, at least 4 must alert positively</i> <u>Correct</u> <u>False Positives</u> <u>Inconclusive</u> 23.5% 0% 76.5%	(division by zero impossible)

Note that there is no difference between Protocols B and C if only the minimum number of two dogs have passed the control trials, and differences arise only if more than two dogs qualify. Thus, in Protocol B, there is a positive identification when out of three qualified dogs, two indicate positively and one negatively. In Protocol C, on the other hand, this would be an inconclusive result. For Protocol C, when four dogs, more than the minimum number, qualify, at least three must indicate positively for a correct identification. The unpublished results also indicated that if only trials were considered in which dogs had performed correctly in all control trials, the percentage of false positives dropped from 34% to 21%, a decrease of false alerts of 13%.

The diagnostic ratios represent a fraction the numerator of which is the percent of correct identifications and the denominator of which is the percent of false identifications. Thus, for a diagnostic ratio of 10, there will be one false identification for every 10 correct alerts. As was noted by Schoon,²⁵⁹ a diagnostic ratio between 10 and 30 (as in Protocol C) would place dog scent lineups in an intermediate category for forensic value. This category includes bloodstain and hair analysis, toolmarks,²⁶⁰ and questioned documents. Using procedures that disqualified some dogs in control trials and taking into account factors that could negatively bias an identification, Schoon estimated that optimal procedures in experiments reported in 1998 obtained a positive identification diagnostic ratio of 13.6.²⁶¹ A ratio below 8 (such as Protocols A and B in Figure 8) would put scent lineups in a more questionable category (which includes paint, glass, and fiber analysis, and analysis of mixed bodily fluids, which have diagnostic ratios between 3 and 8). A ratio above 60 would put scent lineups in the category of some of the best diagnostic procedures, including latent fingerprints, firearms, and shoe impression forensics.²⁶² This would probably include Schoon's Protocol 4 Figure 5 and perhaps Protocol D in Figure 8 (though no ratio could be obtained because of the zero denominator).²⁶³ Eyewitness lineups have been estimated to have diagnostic ratios between 9 and 15.²⁶⁴

Variations in the conduct of experimental protocols may lead to differences in dogs' performance, which in turn will alter the reliability of a given protocol.²⁶⁵ Handlers, aside from early training phases, should be blind to the location of the target scent since they may subtly indicate where the correct scent is hidden, known as the "clever Hans" effect.²⁶⁶ The authors believe that in order to be sure that a dog's alerts are being read correctly, the experimenter should not know the location of the target in a lineup. This requires the experimenter to determine the status of a sample solely on the basis of the dog's indications.²⁶⁷ In any case, if the experimenter does know the location of the target, he should be invisible to both the dog and the handler during the trial. Dogs are extremely good at interpreting human gestures and may alert based on the reaction of the experimenter.²⁶⁸

Certain dogs are better at scent identification than others. One of the authors (Jeziarski) found that in 4,100 trials with six dogs, the best dog performed correctly

²⁵⁹ Schoon (1998).

²⁶⁰ For an argument that identification of striated toolmarks fulfills judicial requirements for admissibility of scientific evidence, see Grzybowski et al. (1998).

²⁶¹ Schoon (1998), 73. Schoon found a much poorer negative identification ratio of 2.6 for negative identifications. Thus, for every 2.6 times a test indicates that an item not alerted to is not the perpetrator, one perpetrator will not be recognized. This asymmetry of positive and negative identification diagnostic ratios shows that positive alerts are more reliable than the absence of an alert.

²⁶² Peterson and Markham (1995).

²⁶³ In a combined trailing and identification study with fragments of car bombs and improvised explosive devices, 25 dogs alerted to the correct "terrorist," while two alerted to decoys, suggesting a diagnostic ratio of 12.5. Curran et al. (2010).

²⁶⁴ Schoon (1998) citing Cutler et al. (1987) and Wagenaar and Veefkind (2002).

²⁶⁵ Schoon (2002). In Poland, one author here (Jeziarski) notes that protocols are more variable than in the Netherlands as the result of variations introduced by osmology experts. This may ultimately reduce the reliability of some results.

²⁶⁶ This effect has been demonstrated in scent lineups by Gawkowski (2000).

²⁶⁷ Jeziarski T., (2002).

²⁶⁸ Soproni et al. (2002); Miklosi et al. (2005).

72.7% of the time whereas the worst was correct in only 32.1% of trials. The percentage of false alerts for the best dog was 15.6% and for the worst 52.8%.²⁶⁹ Dutch research reached similar results with the best dog giving 65% correct indications and the worst 26%, the best dog having 22% false alerts and the worst 59%.²⁷⁰ Thus, the authors believe that scent lineups should not be admitted in criminal prosecutions unless a minimum of two dogs, after control trials, have identified the suspect.

Summary of Protocols Producing High Diagnostic Ratios

For Schoon's 1998 report, the experimental protocol involved using 14 tubes containing odors of seven different people in two rows. Each row contained the odor of a "suspect," the odor of a "check" person, and five decoy odors. The positioning was blind to the handler. A dog was given two trials as a performance check. In these trials, the dog had to match the scents of the check person. Failure to do so led to disqualification. In the next two trials, the dog was given the corpus delicti (crime scene scent) as a sample odor. If the dog retrieved the tube of the suspect, in suspect = perpetrator trials, this was a correct response, but in suspect \neq perpetrator cases, this was a miss. Correct responses in a study of six dogs were correct with a diagnostic ratio of 13.6.²⁷¹ In Schoon's 2002 report,²⁷² where Protocol 4 produced the best results, the number of items in the four lineups was the same, as in the 1998 study, but cloths, rather than steel tubes were used, apparently resulting in a very high diagnostic ratio.

In unpublished results,²⁷³ one protocol (Protocol C in Figure 8) produced a diagnostic ratio of 12.2 and another (Protocol D), because there were no false positives, produced a situation where the diagnostic ratio was probably higher but incalculable because of the impossibility of dividing by zero. In Protocol C, at least two dogs had to pass control and zero trials and positive alerts had to be made by two dogs more than dogs that failed to alert positively. Thus, if only two dogs passed, both had to alert positively. If five dogs passed, four had to alert positively. In Protocol D, at least three dogs had to pass control/zero trials and three dogs more had to alert positively than dogs that did not.

Thus, the most successful protocols involve at least two control trials, and eliminate dogs that do not pass these tests from working trials. It seems also best that at least two dogs, and ideally three, should be required to pass control trials and provide definitive alerts in final trials.²⁷⁴

Comparison with Visual Lineups

False identification of innocent suspects (not foils) may be the most frequent cause of wrongful convictions in the U.S.²⁷⁵ An analysis of actual police lineups in the Greater

²⁶⁹ Jezierski (unpublished results).

²⁷⁰ Schoon (1996).

²⁷¹ The diagnostic ratio includes at least one assumption. Schoon (1998), p. 73.

²⁷² Schoon (2002).

²⁷³ Jezierski (2010).

²⁷⁴ The differences between Schoon's and Jezierski's methodologies and experimental environments do not make precise correlation of their results possible, and variations can arise in experimental processes that might affect results even from the same experimenter.

²⁷⁵ Huff et al. (2000); Scheck et al. (2000); See also Rattner (1988) (52% of 205 cases of proven wrongful convictions were due to mistaken eyewitness identifications).

London area in 1992 found that witnesses picked foils almost 20% of the time. Foils were selected by the police and known not to be involved in the crimes under investigation, but the results also mean that witnesses could have misidentified suspects who were not involved as the perpetrators.²⁷⁶

Photospreads are quite common and have been shown not to be inferior to live lineups.²⁷⁷ In a study where test subjects watched a video of a simulated purse-snatching, the subjects were asked to look at six pictures in two rows of three, one of which might be the “perpetrator” or not. Where the perpetrator was in a picture, a correct identification was made at best 65% of the time. Where the perpetrator was not present, test subjects selected “none of the above,” the correct response, no more than 80% of the time. This meant subjects made a false identification at least 20% of the time. If the pictures were presented one at a time, instead of simultaneously, participants in some trials were right 100% of the time. Other studies have also indicated that sequential lineups, in which the witness sees the lineup participants one at a time, decrease the number of false positive choices while maintaining a similar rate of correct identifications. Nevertheless, simultaneous lineups, in which the suspects are side by side, are still the norm.²⁷⁸ Failure to use double-blind procedures in lineups, where the administrator and those present aside from the witness do not know which person is the suspect, also remains common.²⁷⁹

It has been demonstrated that the instructions given a witness will alter the correct and false identifications, as well as the likelihood the witness will pick no one in a lineup.²⁸⁰ Stress also reduces the accuracy of lineups.²⁸¹ Witnesses have been shown to be better at picking out suspects who are their own age.²⁸² Witnesses who remember peripheral details have been found more likely to make an incorrect identification in a visual lineup than those who do not.²⁸³

V. JUDICIAL STANDARDS FOR ADMISSIBILITY OF SCIENTIFIC EVIDENCE AND PERSPECTIVES ON SCENT LINEUPS

The admission of scent identification evidence, particularly when obtained from scent lineups, has been hotly debated by law enforcement officials, forensic specialists, and lawyers,²⁸⁴ and some initial analysis of the standards by which scientific evidence has been admitted by courts will be helpful when the scientific reports, and the courts’ analysis of canine scent identification evidence, are considered.

²⁷⁶ Wright and McDaid (1996).

²⁷⁷ Cutler et al (1994).

²⁷⁸ Dysart, J.E., and Lindsay (2001).

²⁷⁹ Wright et al. (2009); see also Wells and Seelau (1995) (suggesting four practices to reduce false identifications: (1) the eyewitness should be told the culprit might not be in the lineup, (2) foils should match the witness’s description as well as the suspect does, (3) lineups should be administered by someone who does not know who the suspect is, and (4) witnesses should be asked how certain they are of their choice before other information contaminates their judgment).

²⁸⁰ Clark (2005).

²⁸¹ Deffenbacher et al. (2004).

²⁸² Wright and Stroud (2002).

²⁸³ Cutler et al. (1987).

²⁸⁴ Sometimes members across these disciplines have joined forces to strengthen their positions. See Brisbin et al. (2000).

DAUBERT AND CANINE CASES

The current federal standard for the admissibility of scientific evidence was stated by the Supreme Court in *Daubert v. Merrell Dow Pharmaceuticals, Inc.*²⁸⁵ Justice Blackmun, writing for all the justices on certain issues and all but two (Rehnquist and Stevens) on others, began by noting that *Frye v. U.S.*²⁸⁶ had for 70 years stated the dominant standard for determining the admissibility of novel scientific evidence at trial. *Frye*, discussed separately in the following section, had provided that expert opinion based on a scientific technique is inadmissible unless the technique is “generally accepted” as reliable in the scientific community. *Frye* had dealt with a systolic blood pressure deception test, a precursor to the lie detector. Since the deception test had not received the requisite acceptance in the scientific community, the results of the test were not admissible. The plaintiffs in *Daubert* argued that the *Frye* test had been superseded by the Federal Rules of Evidence, and the Supreme Court agreed.

Rule 401 of the Federal Rules of Evidence provides that relevant evidence is evidence that has “any tendency to make the existence of any fact that is of consequence to the determination of the action more probable or less probable than it would be without the evidence.” Rule 702, governing expert testimony, stated:

If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise.²⁸⁷

The Court noted that the concept of general acceptance from *Frye* is not made a prerequisite under the Rule. The court said the argument that Rule 702 “somehow assimilated *Frye* is unconvincing.” Thus, the “austere standard” of *Frye* should not be applied in federal trials.

Nevertheless, Justice Blackmun argued that Rule 702 contemplates “some degree of regulation of the subjects and theories about which an expert may testify.” The subject of an expert’s testimony must be scientific knowledge, which “implies a grounding in the methods and procedures of science.” Scientific knowledge does not require certainty, and the Court accepted that there may be no certainties in science since scientists are committed to searching for new, temporary theories to explain, as best they can, observed phenomena. The Court said that when Rule 702 requires that evidence or testimony “assist the trier of fact to understand the evidence or to determine a fact in issue,” this goes to relevance.

Faced with a proffer of expert scientific testimony, then, the trial judge must determine at the outset ... whether the expert is proposing to testify to (1) scientific knowledge that (2) will assist the trier of fact to understand or determine a fact in issue. This entails a preliminary assessment of whether the reasoning or

²⁸⁵ *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579, 113 S.Ct. 2786, 125 L.Ed.2d 469 (1993).

²⁸⁶ *Frye v. U.S.*, 54 App.D.C. 46, 293 F. 1013 (Ct. App. 1923).

²⁸⁷ In 2000, this rule was amended by adding “if” after “otherwise,” and providing three qualifications: “... (1) the testimony is based upon sufficient facts or data, (2) the testimony is the product of reliable principles and methods, and (3) the witness has applied the principles and methods reliably to the facts of the case.”

methodology underlying the testimony is scientifically valid and of whether that reasoning or methodology properly can be applied to the facts in issue.²⁸⁸

The Court said that “a key question to be answered in determining whether a theory or technique is scientific knowledge that will assist the trier of fact will be whether it can be (and has been) tested.” Peer review and publication are also important, though not a *sine qua non* of admissibility.

The Supreme Court then stated that the trial court, in the case of a particular scientific technique, “ordinarily should consider the known or potential rate of error,” citing cases concerning spectrographic voice identification analysis.²⁸⁹ Finally, though rejecting the “general acceptance” approach of *Frye*, the Court stated that “[w]idespread acceptance can be an important factor in ruling particular evidence admissible,” such that a technique that has attracted only minimal support in the scientific community “may properly be viewed with skepticism.”²⁹⁰

Blackmun concluded that the inquiry he has enunciated for the Court is a flexible one. He noted that Rule 706 allows a trial court to retain its own expert. He argued that the result of his standard should not be a free-for-all “in which befuddled juries are confounded by absurd and irrational pseudoscientific assertions.” Cross-examination and the burden of proof, and the trial court’s ability to direct judgment are also part of the protection against extreme efforts.

[T]he Rules of Evidence—especially Rule 702—do assign to the trial judge the task of ensuring that an expert’s testimony both rests on a reliable foundation and is relevant to the task at hand. Pertinent evidence based on scientifically valid principles will satisfy those demands.²⁹¹

***Daubert* in Scent Lineups**

Daubert has been referred to in canine-related cases.²⁹² In a 2006 Texas case involving a scent lineup, the handler rejected contentions of the defendant that the lineup was defective because it should have only used scent pads. The handler also deflected criticism that the lineup should have only used people of the same race, and the fact the defendant was the only person in the lineup wearing handcuffs (meaning in effect that the lineup could not have been blind). Despite these flaws, the appellate court determined that the trial court did not abuse its discretion in admitting testimony regarding the lineup.

²⁸⁸ 509 U.S. 592.

²⁸⁹ U.S. v. Smith, 869 F.2d 348 (7th Cir. 1989); U.S. v. Williams, 583 F.2d 1194 (2nd Cir. 1978), cert. denied 439 U.S. 1117, 99 S.Ct. 1025, 59 L.Ed.2d 77 (1979).

²⁹⁰ Citing U.S. v. Downing, 753 F.2d 1224 (3rd Cir. 1985).

²⁹¹ 509 U.S. 597.

²⁹² *Skylstad v. Reynolds*, CV-03-5104-LRS, 2007 WL 2766436 (E.D.Wash. 2007) (trial court cited *Daubert* for its ability to direct a verdict); *Yell v. Kentucky*, 242 S.W.2d 331 (2007) (foundational requirements of qualification of dog and handler, ATF certification, testing and training records, adequate for accelerant detection dog evidence; *Daubert* inapplicable); *Debruler v. Kentucky*, 231 S.W. 752 (2007) (“canine scent tracking is not a technique amenable to peer review or scientific standards and testing. Rather it concerns the behaviors of the dog and the meanings of those behaviors, a knowledge acquired through experience and training. For this reason, foundational evidence of the canine’s scent tracking record; the qualifications of its handler, its training and history provide far more insight into the general reliability of the testimony than a *Daubert* analysis.”).

The trial court had held a hearing to determine if the handler's testimony in a scent lineup would be admitted, and referred to this hearing as a *Daubert* hearing. The court concluded that *Daubert* and *Frye* factors (“(1) whether the theory or technique can be or has been tested, (2) whether the theory or technique has been subjected to peer review or publication, (3) the known or potential rate of error, and (4) general acceptance within the relevant scientific community”) do not necessarily apply outside of the “hard sciences,” and carved out an exception to *Daubert* for scent lineups, looking only to the foundational elements of the qualifications of the trainer, the dog, and the objectivity of the particular lineup.²⁹³ In a 2001 decision of a Texas federal district court involving an alert to drugs,²⁹⁴ the court determined that a *Daubert* hearing was “the wrong procedural vehicle through which to challenge the reliability of a canine alert.”²⁹⁵

Should *Daubert* Admit Scent Lineup Evidence?

As to the *Daubert* test, the authors believe that the scientific and technical knowledge resulting from scent lineups can help the trier of fact determine that the defendant was the perpetrator. To testify as to some aspects of a scent lineup, such as the dog's training and how the trainer recognizes its alert, the trainer would have sufficient expertise. To testify as to the proper procedures for gathering and preserving scent, for explanations of how scents are unique and are recognized by dogs, a scientific background would be required. To testify concerning the conduct of the lineup, and how this conduct is designed to limit erroneous identifications, a handler with sufficient training could be adequate, though some of this testimony might be based on scientific results the handler could not testify concerning.²⁹⁶

Since a court should consider whether the technique involved has been tested, and potential rates of error, it would be appropriate for the court to consider research papers

²⁹³ *Risher v. Texas*, 227 S.W.3d 133 (Tex. Crim. App. 2006); see *Connecticut v. Kelly*, 2009 WL 323481 (Super. Ct. 2009) (agreeing with “widespread belief that dog tracking evidence can be deemed reliable without a *Frye* or *Daubert* inquiry;” the court generally contrasted canine olfaction with the type of expertise held by dog handlers and did not consider that other scientific aspects might be found in tracking evidence beyond olfaction; court also found that a scientific inquiry was “not required because it would be a superfluous confirmation of that which is already known”).

²⁹⁴ *U.S. v. Outlaw*, 134 F.Supp.2d 807 (W.D.Tex 2001). See also *U.S. v. Berrelleza*, 90 Fed.Appx. 361, 365 (10th Cir. 2004) (relying on *U.S. v. Outlaw*); *U.S. v. Morales*, 489 F.Supp.2d 1250 (D.N.M. 2007) (drug dog jumped in open window of vehicle without assistance of agents and alerted, giving agents probable cause to search vehicle).

²⁹⁵ See also *Brooks v. Colorado*, 975 P.2d 1105 (1999) (Supreme Court of Colorado admitted dog tracking evidence as expert testimony not subject to *Daubert* or *Frye* scientific valuation factors). See *Michigan v. Giles*, 2008 WL 2436529 (Mich.App. 2008) (Michigan appellate court was “not persuaded” that scent lineup evidence “was of such a ‘scientific’ nature as to necessitate application of *Daubert*...;” defendant had not challenged methods and procedures used by handler at trial).

²⁹⁶ Courts sometimes seem to depict the scientific basis of scent identification as only involving a discussion of the dog's nose. See *Connecticut v. Kelly*, 2009 WL 323481 (Super. Ct. 2009) (“the fallibility of canine olfaction is common knowledge ... jurors can be made aware of the conditions impacting accuracy during cross, and jurors are free to use their common sense in attributing what weight to accord his type of evidence. The court is persuaded that a juror does not require a scientific explanation of canine olfaction to appreciate that dogs, like all animals, also have flaws and can be influenced by the events taking place around them, both of which can impact their ability to successfully complete the tasks for which they were trained”). Particularly in scent lineups, the accuracy rates of actual identification procedures can be quantified and certainly qualify as a valid scientific inquiry that should inform whether a particular procedure is sufficiently likely to be accurate for admission.

described in this article, with such expertise as needed to understand the research. Widespread acceptance is doubtful, however, at least if scent lineups are to be seen as having a sufficiently high diagnostic ratio to belong with some of the more valuable forensic techniques. As noted above, the most successful protocols have only recently been described, and much prior research, while reaching scientifically significant results, could not be said to be sufficiently reliable to be a particularly useful forensic approach.²⁹⁷

FRYE AND CANINE CASES

The 1923 case of *Frye* had stated that “the thing from which the deduction is made must be sufficiently established to have gained general acceptance in the particular field in which it belongs.”²⁹⁸ As described above, *Daubert* superseded *Frye* in federal courts, but tracking and scent identification cases have been around for a long time and references to *Frye* were common before *Daubert* and continue to be found in state court decisions based on state law that follows a *Frye*-type standard. As with the *Daubert* analysis, courts asked to apply *Frye* to scent identifications have generally declined to do so. A Vermont case from 1979 held that foundational elements for admission of dog tracking evidence were sufficient and did not need to be established by proof of its scientific principles.²⁹⁹ An Arizona case from 1984 involved scent lineups of clothing and bicycles, but the Arizona Supreme Court said that the *Frye* test was inapplicable to dog tracking or scenting, requiring only the foundational requirements of tracking.³⁰⁰ A California appellate court said that every dog’s abilities are different and the reliability of dog tracking evidence was not subject to general scientific proof.³⁰¹ Florida has required that admission of scent lineup evidence involve a demonstration that:

- (1) this type of lineup evidence is reliable; (2) the specific lineup is conducted in a fair, objective manner; and (3) the dog used has been properly trained and found by experience to be reliable in this type of identification.³⁰²

The Florida court said that more evidence was required than the testimony of a dog handler and a police officer, but it is not clear what would establish the reliability of lineup evidence.

²⁹⁷ In Germany, scent identification is an investigative but not a prosecutorial tool. Schoon and Haak (2002) (citing “Richtlinien für den Einsatz von Geruchspurenvergleichshunden im stassrechtlichen Ermittlungsverfahren, RdErl. D. Innenministeriums v. 23.7.1991-IV D 1/C 3 – 6402/8535” in Ministerialblatt für das Land Nordrhein Westfalen, nr. 60, August 28, 1991 (with 2002 amendments incorporated)). In the Netherlands more than a scent discrimination test is needed to prosecute a suspect. Kaldenbach (1998), p. 95.

²⁹⁸ *Frye v. U.S.*, 54 App.D.C. 46, 293 F. 1013 (Ct. App. 1923).

²⁹⁹ *Vermont v. Bourassa*, 137 Vt. 62, 399 A.2d 507 (1979). See also *South Carolina v. White*, 372 S.C. 364, 642 S.E.2d 607 (Ct. App. 2007).

³⁰⁰ *Arizona v. Roscoe*, 145 Ariz. 212, 700 P.2d 1312 (1984) (“We hold, therefore, that dog tracking or identification evidence is admissible in Arizona upon a proper foundational showing that the breeding, training, performance and handling of the particular dog warrants that the results obtained from use of the dog are reliable.”).

³⁰¹ *California v. Craig*, 86 Cal.App.3d 905, 150 Cal.Rptr. 676 (Ct. App. 1978). See *California v. Sandoval*, 2002 WL 519848 (Ct. App. 2002) (following *Craig*).

³⁰² *Ramos v. Florida*, 496 So.2d 121, 122 (1986).

In a 1983 federal district court case from New York, the court concluded, citing only three sources,³⁰³ that “scientific data clearly demonstrate that a properly trained dog can distinguish among the ‘odors’ of different persons and can detect the ‘odor’ of a particular person on an object.” The court also concluded that “the nonlikelihood that two individuals would have similar or identical scents’ or ‘odor’ characteristics has not been established in the scientific community....” The court held that this did not require the exclusion of canine evidence.

Unlike a precise, mechanical instrument such as the spectograph, which jurors may view as incapable of error, a dog may be seen as more “human-like” and therefore subject to lapses in judgment and perception. Thus, because of the lesser potential prejudicial impact that evidence resulting from a dog's identification may have on the jury, courts need not apply as strict a standard when considering the admissibility of such evidence as they are required to apply when considering the admissibility of the seemingly flawless evidence produced by a mechanical instrument.³⁰⁴

The federal district court held that before the canine evidence could be given any consideration or weight, it must find that the dog “has previous actual case lineup experience and that his record in such cases is sufficient to conclude, beyond a reasonable doubt, that his powers of discrimination and identification are reliable.” Then also, as discussed above, the jury must also find that all the other evidence establishes the defendant’s guilt by clear and convincing evidence.

In a 2002 Texas case,³⁰⁵ scent samples were prepared from the crime scenes and from a suspect which were used in a lineup, along with gauze pads from foils. The appellate court considered whether the requirements for admission of scientific evidence established in 1992 by a Texas appellate court should apply. In that case, *Kelly v. Texas*,³⁰⁶ the court established three criteria for determining whether novel scientific evidence could be taken as reliable, and add seven non-exclusive factors to aid in the determination of reliability.

How does the proponent of novel scientific evidence prove it to be reliable? As a matter of common sense, evidence derived from a scientific theory, to be considered reliable, must satisfy three criteria in any particular case: (a) the underlying scientific theory must be valid; (b) the technique applying the theory must be valid; and (c) the technique must have been properly applied on the occasion in question.... Under [state evidence rules] Rule 104(a) and (c) and Rule 702, all three criteria must be proven to the trial court, outside the presence of the jury, before the evidence may be admitted. Factors that could affect a trial court's determination of reliability include, but are not limited to, the following: (1) the extent to which the underlying scientific theory and technique are accepted as valid by the relevant scientific community, if such a community can be

³⁰³ Citing Davis (1974); Hafez (1969); Kalmus (1955).

³⁰⁴ U.S. v. McNiece, 558 F.Supp. 612, 615 (E.D.N.Y. 1983).

³⁰⁵ Winston v. Texas, 78 S.W.3d 522 (Ct. App. 2002).

³⁰⁶ Kelly v. Texas, 824 S.W.2d 568 (Ct. Crim. App. 1992).

ascertained; (2) the qualifications of the experts testifying; (3) the existence of literature supporting or rejecting the underlying scientific theory and technique; (4) the potential rate of error of the technique; (5) the availability of other experts to test and evaluate the technique; (6) the clarity with which the underlying scientific theory and technique can be explained to the court; and (7) the experience and skill of the person(s) who applied the technique on the occasion in question....³⁰⁷

The defendant in *Winston* argued that these factors should be applied to a dog scent lineup. As is likely evident from the prior discussion, the authors of this paper would agree, but the appellate court felt that this was too strict a standard for a scent lineup, however, and looked at another case, *Nenno v. Texas*,³⁰⁸ for a standard to apply “when addressing fields that are based upon experience or training as opposed to scientific methods.” The three factors for such situations, are—

(1) whether the field of expertise is a legitimate one, (2) whether the subject matter of the expert's testimony is within the scope of the field, and (3) whether the expert's testimony properly relies upon or utilizes the principles involved in the field.

The *Winston* court described this as a less rigorous standard but one appropriate for a scent lineup which it described as “based upon training and experience, and not scientific method.” The Texas Court of Appeals considered that the defendant’s appeal concerned the first and third items under *Nenno*, as the subject matter of the expert’s testimony was in the scope of the field. The court stated that although dog-tracking evidence was first admitted in 1904,³⁰⁹ that case was decided under prior standards of expert testimony. On the third prong of the *Nenno* test, whether the testimony relies on or uses principles in the field, the court said this depended on (1) the qualifications of the trainer, (2) the qualifications of the dog, and (3) the objectivity of the lineup. The first two issues were quickly resolved in favor of the state. As to the objectivity of the lineup, the court emphasized that the lineup was apparently conducted with the handler blind as to the position of the suspect’s sample in the lineup. The conviction was affirmed.³¹⁰ In essence, the court affirmed the tracking factors as determining the admissibility of scent lineup evidence and avoided any scientific inquiry.³¹¹

A 2006 Texas case also followed *Nenno*.³¹² The court noted the defense objection that the dog was on medication at the time of the lineups, but found no evidence that this affected her performance, except perhaps to make her a little slower. The medication was apparently for weight loss.³¹³ A court found the lineup objective despite the fact that the

³⁰⁷ 824 S.W.2d 573.

³⁰⁸ *Nenno v. Texas*, 970 S.W.2d 549 (Ct. Crim. App. 1998), overruled on other grounds by *Texas v. Terrazas*, 4 S.W.3d 720 (Ct. Crim. App. 1999).

³⁰⁹ *Parker v. Texas*, 46 Tex.Crim. 461, 80 S.W. 1008 (Ct. Crim. App. 1904).

³¹⁰ *Winston v. Texas*, 78 S.W.3d 522 (Ct. App. 2002).

³¹¹ See also *Pate v. Texas*, 2010 WL 3341853 (Ct. App. 2010) (following *Winston* in finding trial court did not abuse its discretion in admitting scent lineup tests).

³¹² *Nenno v. Texas*, 970 S.W.2d 549 (Ct. Crim. App. 1998).

³¹³ *Risher v. Texas*, 227 S.W.3d 133 (Ct. App. 2006).

procedure was not double-blind (only the defendants were handcuffed), and of the two lineups, only the defendants were different as the other participants were the same three officers.³¹⁴

Dog tracking has been held not to be subject to *Frye*.³¹⁵ The *Frye* standard has been held to be met in the use of cadaver dogs.³¹⁶ An Illinois appellate court held that a dog's alert to accelerants at a fire scene that were not confirmed by laboratory analysis did not meet the *Frye* standard.³¹⁷ A *Frye* analysis regarding a dog's alert to narcotics was unnecessary according to a California appellate court:

Training for narcotics detection work may be more sophisticated and thus a proper subject of expert testimony than training a dog to sit, fetch a ball or stay out of the garbage, but the average juror has some basis in his or her own experiences to muster a healthy skepticism for the expert's testimony on such matters. Most jurors have never seen a polygraph, voiceprint or breathalyzer. Many, however, have everyday contact with dogs. The average juror has had sufficient experience with the subject matter to be able to evaluate the evidence concerning a dog's training, performance, and behavior that the application of the *Kelly/Frye* test to such evidence is unnecessary.³¹⁸

Some cases have avoided *Frye* issues on procedural grounds.³¹⁹

***Frye* in Scent Transfer Unit Cases**

In California cases, *Frye* has been held applicable to the use of a scent transfer unit in the preparation of scent pads for use in a scent lineup.³²⁰ California courts have not always been welcoming of scent transfer unit evidence.³²¹ Several California cases have suggested that dog scent lineups might require further analysis as to the admissibility of

³¹⁴ *Martinez v. Texas*, 2006 WL 3720136 (Ct. App. 2006).

³¹⁵ *California v. Beverford*, 2008 WL 1799763 (Ct. App. 2008).

³¹⁶ *Clark v. Maryland*, 140 Md.App. 540, 781 A.2d 913 (Ct. Spec. App. 2001); *New York v. Shulman*, 6 N.Y.3d 1, 843 N.E.2d 125, 809 N.Y.S.2d 485 (2005) (sufficient evidence regarding serial murders that challenge to dog scent evidence did not need to be addressed).

³¹⁷ *Illinois v. Acri*, 277 Ill.App.3d 1030, 662 N.E.2d 115 (Ct. App. 1996).

³¹⁸ *California v. Sommer*, 12 Cal. Ap.4th 1642, 1655, 16 Cal.Rptr.2d 165, 173 (Ct. App. 1993).

³¹⁹ *California v. Schoppe-Rico*, 140 Cal.App.4th 1370 (Ct. App. 2006) (failure to conduct *Frye* hearing on admission of dog evidence was not prejudicial as it was not reasonably likely jury would have reached other verdict had dog evidence been excluded); *California v. Chavez*, 2004 WL 1173075 (Ct. App. 2204) (court accepted evidence but noted laxity in raising issue); *California v. Loaiza*, 2005 WL 237258 (Ct. App. 2005) (failure to object at trial means issue is not preserved on appeal even though law may have been changing at the time); *California v. Melara*, 2006 WL 164989 (Ct. App. 2005) (defense sought to introduce exonerating scent evidence obtained in part from scent transfer unit, but failed to produce proper expert, only dog handlers); *California v. Adams*, 2008 WL 21153557 (Ct. App. 2008) (objection based on *Frye* not made at trial); *Aguilar v. Woodford*, 2009 WL 509127 (C.D.Cal. 2009) (not reasonably probable result would have been different even if dog scent evidence had been excluded).

³²⁰ *California v. Salcido*, GA052057 (Super. Ct. 2005), considering the requirements of *California v. Kelly*, 17 Cal.3d 24, 130 Cal.Rptr. 144, 549 P.2d 1240 (1976); see also *California v. Alonzo*, 2008 WL 2248628 (Ct. App. 2008). The cases often describe *Kelly-Frye* hearings, referring to the leading California case adopting *Frye* for state purposes. *California v. Kelly*, 17 Cal.3d 24, 130 Cal.Rptr. 144, 549 P.2d 1240 (1976).

³²¹ See, e.g., *California v. Melara*, 2006 WL 164989 (Ct. App. 2006).

such evidence, but nevertheless affirmed convictions because of a finding that any error in admitting the scent identifications or procedures used in such identifications was harmless.³²²

Applying Frye to Scent Lineups

In 1990, Professor Taslitz argued that scent lineups were too unreliable to provide valid evidence in criminal prosecutions, partially on the basis that scent lineups could not meet *Frye* standards.³²³

The courts' irrational handling of scent lineups also reflects the judiciary's fundamental failure to recognize the mythic qualities of the supposedly infallible dog's power and to understand the role science plays in the law of evidence.³²⁴

Taslitz's perspective has been widely influential, and his article has probably been cited more often than any other academic legal analysis in this area. In 1999, a Polish professor of forensic science, summarizing European research, found Taslitz's opinions to be still valid.³²⁵ Writing before *Daubert*, Professor Taslitz posed five questions that he asserted must be answered affirmatively if dog scent lineups are to pass the *Frye* test:

(1) Does each person have a unique scent? (2) If yes, is there a "core scent" that stays the same over time, despite changes in individual mood, diet, clothes, cologne, and similar factors? (3) If yes, are at least some dogs biologically capable of discriminating among the unique human body scents? (4) If so, can those dogs be trained to use their capability accurately whenever so commanded by their handlers? (5) If those dogs can be so trained, how much time can elapse between the application of scent to the object and the holding of the lineup after which the dogs still can discriminate successfully among scents?

Taslitz described the first two questions as going to validity, and the latter three as going to both validity and reliability. He concluded that scent lineups "do not pass the *Frye* test." The authors believe that these questions can be answered with qualifications that allow for scent lineup procedures to be employed in criminal prosecutions:

1. Each person has a sufficiently unique scent that an appropriately designed procedure can have a high probability of allowing dogs to distinguish a person's scent from a lineup of scents from other persons.
2. There is a core, or primary scent, probably based on genetic factors, that remains substantially stable over time, despite changes in secondary and

³²² California v. Hackett, 2003 WL 463976 (Ct. App. 2003); California v. Mitchell, 110 Cal.App.4th 772, 2 Cal.Rptr.3d 49 (Ct. App. 2003).

³²³ Taslitz did note that unpublished research by de Bruin (who later worked with Schoon) might be leading to fairer procedures. Taslitz (1990), 71.

³²⁴ Taslitz (1999). Excessive faith in the abilities of dogs may make acceptance of bloodhound testimony dangerous for the defendant, but there have been times where excessive doubt may have negated valid evidence. One police dog expert describes a murder where press suspicions of a dog's abilities may have influenced both public and judicial opinion. Kaldenbach (1998), 132-9.

³²⁵ Wojcikiewicz (1999).

tertiary factors affecting other aspects of the scent of an individual. Secondary and tertiary factors should, to the maximum extent possible, be equalized in a scent lineup.

3. Some dogs are biologically capable of discriminating among the unique human body scents, but protocols should provide for testing a dog's willingness to work in a particular set of trials, and enough dogs should be used that the indications given by the dogs can cumulatively provide a sufficiently high diagnostic ratio for use of the results in a criminal prosecution.
4. Dogs can be trained to alert to individual human scents in scent matching procedures, but dogs should also be tested in control trials before being used in a particular lineup.
5. Substantial amounts of time can elapse between the time the scent was placed on an object and the time that the scent lineup occurs, but the accuracy of the dogs will decrease if the scent is not appropriately preserved and becomes weaker with time. A weaker scent is more likely to produce no alert, but the defense should be able to demonstrate the reduced value of the scent in a lineup as a result of aging. Uses of multiple dogs are particularly important in such cases.

The authors believe that the general scientific acceptance requirement of the *Frye* standard should not be a requirement for the admission of scent lineup evidence, in that there is a significant literature on the subject and the evidence can be made sufficiently reliable to assist the trier of fact. On the other hand, the authors also believe that the *Daubert* requirements are appropriate, and the traditional foundational requirements of tracking cases are inadequate for admission of scent lineup evidence in criminal prosecutions.

FOREIGN JUDICIAL PERSPECTIVES ON SCENT LINEUPS

The Dutch Supreme Court has been accepting scent lineups since 2001.³²⁶ German courts have shown more caution, admitting scent lineups only as circumstantial evidence, but forensic publications after 2000 are paying more attention to this methodology.³²⁷ Polish courts also recognized scent lineups as circumstantial and of limited probative value,³²⁸ but in 1999, Poland's Supreme Court provided specific requirements for the admissibility of scent identification evidence.³²⁹ This court specified that an expert in the area of scent examination should be appointed not to provide an opinion on the correctness of scent lineups carried out by the police, but rather to conduct scent lineups

³²⁶ Tomaszewski and Girdwoyn (2006), pp. 192 and 195, n. 4, citing AD5148 No. 01327/01 (November 21, 2001); AE8856, No. 01707/01 (November 5, 2002) (scent recovered from firearms matched to scent collected from suspect); AF5388, No. 01890/02 (March 25, 2003) (dog alerted to samples of suspect in two lineups).

³²⁷ Tomaszewski and Girdwoyn (2006), pp. 192 and 195, n. 5.

³²⁸ Tomaszewski and Girdwoyn (2006), pp. 192 and 195, ns. 9, 10.

³²⁹ Tomaszewski and Girdwoyn (2006), pp. 192 and 195, n. 11, citing 05.11.1999 Supreme Court sentence V KKN 440/99 OSNKW 1999/11-12/76 (November 5, 1999); II KKN 467/99 LEX No. 53895 (May 7, 2002).

using relevant specialists to collect scent samples, and dog handlers for the lineups.³³⁰ Polish courts require (1) two separate lineups, (2) proof that the dog has been shown reliable, (3) a demonstration that appropriate foils were selected, and (4) placing items in the lineup was done blind, without the dog or handler present.³³¹

Tomaszewski and Girdwoyn note that the acceptance of scent lineups in Poland has changed dramatically in that such evidence was initially circumstantial, but then began to be regarded as expert testimony, and that sometimes it was accepted as the only incriminating evidence sufficient to prove the defendant guilty.³³² Then some notorious cases somewhat lessened the value courts were willing to give to scent lineups, which began to emphasize again that it could only be circumstantial, and would have to be evaluated in relation to the totality of the evidence presented.³³³ A 2003 Supreme Court decision stated:

So far, scent evidence has not provided such certainty as can be derived, for instance, from fingerprint or DNA examinations, and hence the need of preserving a high dose of precaution in judicial decisions when basing sentences exclusively on scent evidence. While avoiding disapproval, this type of evidence should be subject to a penetrating and comprehensive analysis with due respect to other evidential material.³³⁴

Tomaszewski and Girdwoyn describe an increasing skepticism.

In Lithuania and the Ukraine, dog scent lineups are used as investigative tools but not as evidence in court.³³⁵ An increasing skepticism has been noted in Europe.³³⁶

VI. CONCLUSION

Scent lineups can be a powerful tool in the investigation of crimes. With proper procedures, both forensic and judicial, scent lineups can be valuable evidence for a jury to consider. Unfortunately, many courts have been willing to admit poorly conducted procedures, even if giving lip service to the fact that the scent lineup was deficient by saying that its admission was harmless error. The tendency of some courts to view scent lineups as an extension of scent tracking has resulted in admission of scent lineup evidence under inappropriate standards. Tracking cases have set foundational

³³⁰ Tomaszewski and Girdwoyn (2006), pp. 192 and 195, n. 12, citing IV KKN 269/99 LEX No. 51139 (January 12, 2000).

³³¹ Tomaszewski and Girdwoyn (2006), pp. 192 and 195, n. 13, 14.

³³² Tomaszewski and Girdwoyn (2006), pp. 192 and 195, n. 16, citing SN III KKN 333/98 LEX No. 52013 (February 5, 2001).

³³³ Tomaszewski and Girdwoyn (2006), pp. 192 and 195, n. 17, citing 2002.05.29 sentence of Court of Appeal II Aka 94/02 KZS 2002/9/14 Cracow (September 14, 2002); SN V KKN 283/01 LEX No. 56843 (October 21, 2002).

³³⁴ One author here (Ensminger) has modified the translation reproduced by Tomaszewski and Girdwoyn (2006), 192.

³³⁵ Wojcikiewicz (1999).

³³⁶ For European academic legal perspectives also doubting scent lineups as valid evidence, see Jaworski (1999); Widacki (1999); Widacki (2000). Increasing skepticism about the reliability of the canine identification of perpetrators using scent lineup resulted lately in nullifying retrospectively a number of positive lineups by the State Attorney General in the Netherlands (Prof Jan E.R. Frijters, personal information, 2009).

requirements from long-held social and judicial assumptions about the accuracy of dogs. The authors take no position here on the appropriateness of the traditional foundation elements for tracking cases, but believe that these elements are insufficient for scent identifications.

Although no set of training procedures or testing protocols need be imposed under the current research posture, a protocol with elements that have produced a diagnostic ratio greater than 10 should be required for admission of scent lineup evidence in a criminal prosecution. Dogs should be trained in a series of stages and should not be approved for working trials until they have high proficiency ratios in test trials. Samples should be prepared under rigorous standards that eliminate contamination to the extent possible. Cloth or metal tubes may be used, but the choice of such items will affect the frequency with which objects in the lineups are changed. Handlers and experimenters visible to the dog should be blind as to the location of target scents. Control trials should determine if a dog is willing to work on a particular day or is overly attracted to a suspect's scent, and failure during control trials should preclude the dog's participation in a final evidentiary trial. Some control trials should probably be zero trials in which no choice is correct. At least two, but preferably three dogs should alert to a suspect's scent in a final trial for the evidence to be advanced as trial evidence (and the number of dogs not alerting correctly should be at least two or three less than the number of dogs alerting correctly). A failure to reach a trial evidence level does not preclude a record of an alert being kept as part of the investigation of a crime.

Rigorous research should continue both as to the science and behavior of dogs, and the optimal procedures for conducting scent identifications. Better coordination between FBI resources and state and local police departments could lead to more solid scent lineup evidence, which can be particularly useful in cases where witnesses tend to disappear or refuse to cooperate with visual lineups. Nevertheless, because the possibility of a false identification cannot be completely eliminated, corroboration by other evidence should be required, probably at a clear and convincing level.

With such cautions and parameters it is appropriate to allow scent lineup evidence in criminal prosecutions.

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