

P.J. van Koppen (1995) Sniffing experts: Theory and practise of scent line-ups. *Expert Evidence*, 3, 103-108

Sniffing Experts: Theory and Practice of Scent Line-Ups

Peter J. van Koppen

Netherlands Institute for the Study of Criminality and Law Enforcement, Witte Singel 103, 2313 AA Leiden, The Netherlands.

Abstract: The scent line-up is a procedure in which a specially trained dog is used to examine whether the odour of a suspect is the same as the odour on an object found at the scene on the crime. In this article it is concluded that the scent line-up is a potentially powerful piece of evidence. However, our knowledge of the scenting abilities of dogs is sparse. The scent line-up, therefore, can only be a powerful piece of evidence if the line-up is performed according to a rigorously held procedure. Common procedural errors are discussed, comparing the scent line-up to the visual line-up.

Introduction

It is not simple to enter the United States. Even if the visitor is neither homosexual nor communist, the procedure of entry seems to be aimed at impressing the visitor that soon a considerable privilege may be granted. The time of waiting before U.S. Immigrations is only enlightened by one interesting event: the work of the *Beagle Brigade*. A beagle passes along the immense queue to detect the scent of food; bringing food into the United States is also not allowed. If the dog sits next to a person, there always proves to be something like an apple in his or her handbag.

The work of the beagles in the United States is one of the many ways in which dogs are helping to fight crime. They are useful, because of two characteristics of dogs: their amazing scenting ability and their receptivity to training. Specially trained dogs are used in many ways: to find people after an avalanche, finding food and drugs in bags and trunks; finding explosives; finding people in demolished buildings after an earthquake; and following a scent track in the woods. All these have one element in common: the dog is used to detect one or certain types of odours - human, fruits, heroin.

Dogs are also used to establish whether an object has been in the hands of a particular person. That is quite another task: rather than finding a certain kind of odour, the dog has to *discriminate* between different odours of the same kind, a task which is comparable to the task faced by a witness in a visual line-up.

Broadly speaking, the scent line-up works as follows. The dog handler lets the dog sniff an object which has been in the hands of the perpetrator. Next, the dog is offered odours of a number of individuals: the suspect and some foils. The dog attempts to indicate if the scent of one of the individuals is the same as the scent on the object.

In this paper I will discuss the scent line-up, comparing it to the visual lineup. I will argue that our lack of knowledge on

the scenting ability of the dog has to be compensated by a strict procedure.

Possible outcomes

The problems associated with the scent line-up can best be introduced by returning to the *Beagle Brigade*. My own observations of the work of these dogs show that the dog is always correct if it sits next to some luggage and indicates that food must be in it. That does not mean that the work of the beagles is without failure, because the coffee I always take to the United States is never detected. In summary, the work of the beagles can have the outcomes depicted in Table 1. The table shows that the ability of the beagles is only partly known: apparently these dogs do not make false positives, but the number of false negatives is unknown. These false negatives need not be caused by bad performance of the dogs; the most skilled dog will probably also pass by my vacuum packed coffee.

<i>Dog's behaviour</i>		
<i>Reality</i>	<i>Sits next to passenger</i>	<i>Passes passenger</i>
<i>Passenger did not take food</i>	<i>False positive</i>	<i>Correct</i>
<i>Passenger took food</i>	<i>Correct</i>	<i>False negative</i>

Table 1: Possible outcomes of work of beagle.

The scent line-up can have a large number of outcomes (see Table 2). The kind of error made, however, does have an indication of the cause of the error. These can be manifold: bad training of the dog; the perpetrator left too little scent on the object; the object has not been properly looked after by the police; the scent of the foil and the suspect may be too alike; or the test was badly performed. I return to these possibilities below. First I discuss the assumptions underlying the scent line-up.

Behaviour of the dog

<i>Reality</i>	Indicates suspect	Indicates foil	Indicates nobody
Object has not been handled by suspect	False positive	False	Correct
Object has been handled by suspect	Correct	False	False negative

Table 2: Possible outcomes of scent line-up.

Assumptions underlying the scent line-up

The most important assumption underlying the scent line-up is that dogs - or the kind of dogs used for the line-up - are able to discriminate between different human odours. This assumption is based upon anecdotes, because there has been little research on the scenting ability of dogs (see Taslitz, 1990). It is a fair assumption that dogs have a much stronger scenting ability than human beings, but that does not mean that they can discriminate perfectly between different human odours. Our lack of knowledge requires that the connection, made by the dog between an object and the persons who have handled the object, is examined in a critical test. It will not be enough to have the dog smell the object and the suspect and to let the dog indicate - for instance by barking - that the odours are the same. The job should be tougher for the dog; it should choose between a number of human odours in a situation in which there are no other cues for the dog than the odours themselves.

It is also assumed that each human being has an identifiable and unique odour, or at least that the probability that two out of six individuals - the most common size of a scent line-up - have the same odour is extremely low. It is generally assumed that each human being has a unique odour, but some studies seem to support the opposite (Taslitz, 1990). One problem with this assumption is that it is strongly connected to the first assumption - that dogs can discriminate between different human odours - because there is no way in which we can check the choice made by the dog in practice. Only specially designed experiments would allow a check on the performance of the dogs.

The assumption that dogs can discriminate between human odours was supported in studies by Buytendijk (1973) and Hepper (1988). Buytendijk used a single dog, who successfully chose from three odours in 16 out of 22 attempts. These odours, however, were not human, but mixtures of acids which are common in human odours. Hepper's dogs had to connect both identical and non-identical twins to a t-shirt worn by one of them. The four dogs were right more than 80 percent of the time if the twins were different in environment and diet. With identical twins living on the same diet, the dogs could not outperform chance. This means that dogs cannot discriminate between twins who normally live together; only if the twins were separated for some time and have lived on different diets, dogs could discriminate between their odours. Only

recently, Ferstl *et al.* (1992) indeed found support for the hypothesis that human odours are genetically based. They trained rats to discriminate between urine odours of humans who differed in their HLA class 1 type. These rats discriminated correctly in 75 percent of the trials between three pairs of urine.

The experiments of Buytendijk, Hepper and Ferstl *et al.* allow some tentative conclusions. First, that there are differences between at least some individual odours and that dogs can detect these differences. Second, at least part of the human odour is genetically determined. Thirdly, that the environments or the diet or both influence human odour. These experiments, however, were too limited in scope to allow for the conclusion that humans have unique odours or odours which are unique enough to use the scent line-up as evidence. Before that conclusion can be drawn, many more experiments are necessary.

The third assumption underlies some but not all of the line-ups, namely that different parts of the human body have the same odour. Often the odour of the hands of the suspect and foils are compared to objects that must have been in contact with another part of the body of the perpetrator. After a bank robbery, for instance, a specially prepared cloth is routinely put on the front seat of the runaway car by the police. The cloth draws up any scent from the seat and is kept in a glass jar for use in a future scent line-up. Studies by Brisbin and Austad (1989; cited by Taslitz, 1990), however, show that dogs have difficulties in comparing odours from different body parts. Therefore, it can be expected that dogs make more errors in such a scent line-up.

The fourth assumption holds that individual odours do not change over time. Commonly, there is a time lapse between the crime and the scent line-up. In fact this assumption contains two propositions: the unique elements in human odours do not change, or change little over time, and the odour on the object from the scene of the crime does not change or changes little over time.

Human odour consists both of dead material (mostly acids) and live material (bacterial and bacterial-created components). It can be expected that, even if the object found at the scene of the crime is kept in a thoroughly cleaned jar, the microbes can change the odour over time. How strong this effect is, is unknown. King, Becker and Markee (1964) found that until about six weeks after the crime the dogs performed fairly accurately (also Hilden, 1991). De Bruin (1992) even claims successful scent line-ups after three years.

It is unclear whether the assumption holds that the odours of individuals do not change over time. Humans may have an unique odour at one point in time, but under changing environmental conditions or with a changed diet, the odour might change dramatically. Hepper's (1988) study showed that diet or environment can have an influence on the odour, but how much remains unclear.

The fifth and final assumption underlying the scent line-up, then, has to be that dogs can discriminate individual human odours or elements in odours which are unrelated to influences of environment or diet. Again this assumption is not supported by any research.

Procedure

The meagre support for some and the lack of support for other assumptions underlying the scent line-up, calls for critical distrust of the scenting abilities of the dog; not because dogs cannot be trusted, but because we know so little on this topic. To compensate for our lack of knowledge, the scent line-up must be a critical test. A critical test must be based on the simple principle that every element of the procedure is aimed at securing that nothing but the odours can cause the dog to connect the object to the suspect. The principle might be simple; practice is much more complicated. To direct the practice of the scent line-up an analogy with the visual line-up can be useful. The logic of the visual line-ups is simple. It is assumed that the witness and the suspect are unfamiliar with each other. If the suspect is the perpetrator, the witness has seen him or her only once: at the scene of the crime. If the suspect is innocent, the witness has never seen him or her before. If the witness points out the suspect, the witness must have seen the suspect before and thus the suspect is the perpetrator. This conclusion, of course, can only be drawn after a good line-up and with a certain probability, depending on the size of the line-up.

Organising a good line-up is a troublesome affair. It would be much simpler to have the dog compare the odour on the object with just the odour of the suspect. As said, a more difficult task for the dog is called for. But we do not know how much more difficult the introduction of a number of foils is for the dog. That can be made clear by imagining the foils as colours. Suppose that the object has a 'red' odour for the dog. If the suspect has some kind of red odour also, and all the foils are brown or blue, the choice is not made any more difficult for the dog than in a single person line-up. I return to that problem below.

The value that can be given to the results of a scent line-up as evidence can be expressed in the diagnostic value of that test (see Wagenaar, Van Koppen & Crombag, 1993, chpt. 3). The diagnostic value of a connection of the object to the suspect is computed with Formula 1 (compare Formula 1 to Table 2.)

$$\text{Diagnostic value indicates suspect} = \frac{\text{Correct indications}}{\text{False-positives}}$$

Formula 1.

Table 2 shows that the diagnostic value of the result 'indicates suspect' can only be computed if empirical data are available on the number of times the dog indicates the suspect, if the suspect handled the object *and* if data are available on perpetrator-absent line-ups. The first kind of data are unavailable, because the research to date had little to do with real scent line-ups: the second kind of data have never been gathered. Thus, the diagnostic value is neither large nor small, but simply unknown as is the weight the judge or jury should give the result of the scent fine-up. Based on logic, reasonable suppositions and an analogy to the visual line-up, however, some indication can be given how a good procedure could improve the diagnostic value of the scent line-up.

History of errors

Almost all errors than can be made - and in the past were made - in a scent lineup have an analogy in the visual line-up. The common theme of all errors in the procedure of the visual line-up is that these errors enhance the probability that the witness indicates the suspect on grounds other than recognition from the scene of the crime. Procedural flaws in the visual line-up have been extensively documented (Clifford & Davies, 1989; Gross, 1987; Wagenaar, 1988; Wagenaar, Van Koppen & Crombag, 1993). Possible errors in the scent line-up have the same theme: they all may provide indications to the dog, other than the scent of the object, of whom is the suspect. I will briefly discuss errors made in the past using the scent line-up. Recently, the procedure for the scent line-up in The Netherlands has been changed to evade most of these errors (*Keuringsreglement Politiepeurhond Menselijke Geur*, 1992), but still many errors are possible.

Of course the most basic error is to perform the scent line-up with an insufficiently trained dog. In the past, sometimes, Dutch police officers performed scent line-ups with dogs which received little training. Recently, the qualifications necessary to pass a national exam (see *Keuringsreglement Politiepeurhond Menselijke Geur*, 1992) were introduced by the Dutch government. The exam applies to dogs specialized in human odour, and also to their handler. It takes about a year to train dog and handler for their task. Only dogs and handlers who passed the national exam are allowed to perform scent line-ups. The exam is repeated each year to keep the standard high.

Other errors in the history of the scent line-up concerned the manner in which the line-up was performed. In the first versions of the scent line-up the dogs had to choose between the suspect and the foils in person. It will be clear that - for instance, because the suspect is more likely to be nervous than the foils - the choice made by the dog could be based on minimal non-odour cues. Therefore, in a later version of the procedure, the suspect and foils were put behind a screen, sometimes with a ventilator behind each of them to blow their odours to the dog. In order to prevent the possibility of any minimal non-odour cue from the suspect

and the foils, in an even later version, the dog had to choose between stainless steel tubes which had been held by the suspect and foils for some ten minutes. Before the individuals in the line-up take the tubes in their hands, they all wash their hands thoroughly with the same perfumeless soap.

These developments did not remove all possibilities of minimal non-odour cues, because the dog handler was another source. Quite recently, therefore, a helper was introduced into the procedure who collected the tubes and laid them out on the floor, outside the sight of both dog and dog handler.

Remaining logical flaws in the scent line-ups

Known suspect or foils

The first error which is still possible under Dutch procedure is that the dog already knows the suspect. If so, the line-up is flawed, because the dog smells a known odour in between unknown odours in the line-up. Dutch procedure prescribes that the same dog cannot be used for a line-up with the same suspect within a 14 day period. This is not a meaningless rule. If, for instance, an individual is suspected of a bank robbery, the police routinely search unsolved robberies for commonalities in *modus operandi*. Often multiple objects with the odour of the perpetrators are available for each robbery. Given the limited number of dogs that are trained for the scent line-up, performing a line-up for all objects can pose a problem. Nevertheless, the 14 day term seems to be based on practical grounds, rather than knowledge of the dog's scenting abilities. If these abilities are as amazing as is often assumed, a 14 day term seems to be far too short.

If the foils are drawn from the police force, as is common in The Netherlands, many foils may have participated in previous scent line-ups with the same dog. Even if a police officer/foil did not participate in previous line-ups, the dog may be familiar with the officer's odour. The dog and the dog handler travel around police stations in the country to perform scent line-ups and during the years the dog may have been in all but a few police stations in the country. There is no rule in Dutch procedure which requires the handler to leave the dog in the car until the line-up is executed. Thus, the dog may know many of the police officers who are used as foils. If so, the odour of the suspect may be the only unknown odour or one of the few unknown odours for the dog in between known odours. In such a line-up, familiarity of odours may provide a cue for the dog.

The foils should not come from a homogeneous group

Using police officers as foils is also an error in another respect. The study by Hepper (1988) showed that both environment and diet can have an influence on odour. If police officers are routinely used as foils, the odour of the suspect may be the only one that stands out in the line-up

and thus serve as a cue to the dog. The remedy is simple, but involves extra work: ban police officers as foils and ban any other homogeneous group as foils.

Wrong foils

It is not just enough to have foils who do not come from a homogeneous group. Since we know so little of what affects the dog's ability, the foils should at least be of the same gender and race as the suspect. Additionally, the foils should come from the same environment as the suspect and should at least roughly eat the same diet. It seems unsound to organize a line-up with a garlic-eating suspect among foils who are hooked on the Dutch cuisine.

Multiple suspects

An all suspect line-up should be banned for obvious reasons: there is no way to tell whether the dog failed or not (see the arguments given for the visual line-up by Wells, 1993, p. 556 ff.). If two or more suspects are placed among innocent foils, it should be realized that the effective size of the line-up is reduced (Brigham & Brandt, 1992). More important, having multiple suspects in the same line-up can have peculiar consequences if it is not clear, beforehand, that only one suspect handled the object. Take, for instance, a case in which the object is a gun used in a robbery committed by two perpetrators. Two individuals, suspected of having committed the robbery together, are put in a line-up among innocent foils. If the suspects indeed are the two perpetrators, it is quite possible that both had the same gun in their hands before the robbery. During the scent line-up two things can happen. The dog may hesitate because it recognized both odours, and from this the handler may decide that the line-up has a negative result. Or the dog may pick the tube of only one of the suspects, thus incorrectly absolving one of the real perpetrators.

Repeated testing

In Dutch practice the line-up is routinely repeated. Before the most recent change in procedure, the suspect's tube was taken away and replaced with a second tube held by the suspect. The second tube was laid in another place in the line-up, but the tubes of the foils were the same in both tests. For obvious reasons - i.e., the possibility cannot be excluded that the dog senses that it has already touched the tubes of the foils - that practice has been abandoned.

Under current procedure two line-ups are still performed. Now, one of the line-ups is blind, i.e. without the suspect (Malpass & Devine, 1981). The sequence of the two line-ups is chosen randomly. The blind line-up is used to demonstrate that the dog is able to abstain from picking a tube if no odour is recognized. The line-ups are declared negative if the dog picks a tube in the blind line-up, even though it picked the suspect in the other.

Negative line-ups

If the dog picks the suspect's tube, the conclusion is obvious: the probability that the suspect indeed is the perpetrator is increased. The conclusions that can be drawn from a negative line-up - in which the dog either refuses to pick a

tube or picks a foil - are less obvious. Maybe the suspect is innocent; maybe the object was obtained and kept badly; maybe too little odour of the perpetrator was transferred to the object; maybe the dog was badly trained or had an off-day.

Here is an example. In a case, in which I served as an expert witness, the defendant was accused of being one of two criminals who had together robbed four banks. In all four robberies they acted almost identically. They drove to the bank in a stolen car. After entering the bank, one of the two demolished the bulletproof window of the counter with a sledgehammer. With a considerable amount of money, but without the sledgehammer and their guns, they fled from the bank. *En route* they changed to another stolen car. For one robbery the sledgehammer was used as the object in the scent line-up; for the second robbery both the sledgehammer and a pedal taken from the first runaway car were used; for the third robbery a pedal from the car and the driver's seat were used; and for the fourth robbery the gearstick and a gun were used. The police could not give an explanation why so many different objects were used. It seems reasonable to expect that more odour can be found on a gearstick than on a pedal. If, using a pedal, the dog picks the suspect's tube, the scent line-up is a powerful piece of evidence against the defendant. If the dog refuses to pick any tube, the line-up is *not* a strong piece of evidence in favour of the defendant because it can always be argued that it is unlikely that the perpetrators left odour on a car pedal.

The example shows that a fair scent line-up - i.e. a scent line-up that may give a result in favour of the suspect - can only be guaranteed if before the line-up is performed the police can demonstrate the probability that odour of the perpetrator is on the object; that the object is obtained in a proper manner; and that the object is kept in a proper manner. To protect the interests of defendants, there should be standardized procedures for securing and keeping objects for scent line-ups.

Scent is sequential

All of the possible errors in the scent line-up discussed above are also possible in the visual line-up. But some of the errors possible in the visual line-up are not possible in the scent line-up. Errors that relate to the interest witnesses may have in identifying somebody are not possible. More important, in the scent line-up the odours are always presented sequentially to the dog. It passes along the tubes, sniffing each and, if a match to the odour of the object is found, the dog does not continue, but brings the tube to the handler. The sequential effect is enhanced if pieces of cloth in glass jars are used instead of tubes. Then the dog really has to put its nose into each jar to smell the odour.

The sequential line-up was proposed for the visual line-up to preclude relative judgement by witnesses at simultaneous line-ups, i.e. to prevent witnesses from indicating the individual who merely looks most like the perpetrator, rather than indicating upon recognition (Clifford & Bull, 1978; Lindsay, Lea & Fulford, 1991; Lindsay, Lea, Nosworthy, Fulford, Hector, LeVan & Seabrook, 1991; Lindsay & Wells, 1985; Wells, 1993). In a sequential visual line-up the witness is presented with the participants, suspect and foils, one by one and has to decide with each whether or not the individual is recognized as the suspect. The witness is not allowed to go back to individuals previously presented. The same happens in a scent line-up, thus preventing the dog from using relative judgement. There, however, is one exception: under Dutch procedure the dog is allowed to go back along the line once, if it did not pick a tube on the first run. If the dog picked the tube in the second run, this should at least be reported to the defence and the court.

The scent line-up as evidence

The results of the scent line-up can be used in two ways: as information in the police investigation and as evidence at trial. Most of the time the scent line-up will be of little use to the police investigation because a line-up is only possible if there is a suspect who has been apprehended on other grounds than his or her odour. At the same time this is a point about the strength of the scent line-up as evidence. With visual line-ups it is possible to make the following mistake. Sometimes suspects are arrested because they look like the perpetrator. If in a subsequent visual line-up the suspect is identified by different witnesses, these line-ups have the appearance of providing solid evidence, even though they just confirm the original suspicion based on the appearance of the suspect (see Gross 1987, for some resulting miscarriages of justice).

We do not know how much the scent line-up is worth as evidence. The scent line-up lacks solid empirical research on which the diagnostic value can be estimated. The potential difficulties and the lack of research, however, should not result in the decision to reject the scent line-up as evidence in court, because all but a few means of evidence have difficulties and lack of research. Except for the recognition task, we know nothing of the diagnostic value of the most common form of evidence: the witness. And even most parts of forensic sciences, such as bullet comparison and fingerprints, lack a solid empirical basis (Saks, 1993). Courts, however, should only accept the scent line-up as evidence if the police rigorously upheld a procedure which excluded most logically alternative explanations for the fact that the dog only used the odour to pick the suspect from the line. The above is meant to contribute to the design of such a procedure.

References

- Brigham, J.C. and Brandt, C.C., 1992, Measuring lineup fairness: Mock witness responses versus direct evaluation of lineups, *Law and Human Behavior*, 16: 475-489.
- Brisbin Jr, and Austad, S., 1989, *Testing the individual odor theory of canine olfaction*, Unpublished manuscript.
- Bruin, J.C. de, 1992, *De speurhond en de sorteerproef*, Unpublished manuscript.
- Buytendijk, F., 1973, *The mind of the dog*, New York: Arno.
- Clifford, B.R. and Bull, R., 1978, *The psychology of person identification*, London: Routledge.
- Clifford, B.R. and Davies, S., 1989, Procedures for obtaining identification evidence, (in) Raskin, D.C., (ed.) *Psychological methods in criminal investigation and evidence*, New York: Springer.
- Gross, S.R., 1987, Loss of innocence: Eyewitness identification and proof of guilt, *Journal of Legal Studies*, 16: 395-453.
- Ferstl, R., Eggert, F., Westphal, E., Zavazava, N. and Muller-Ruchholtz, W., 1992, MHC-related odors in humans, (in) Doty, R.L. and Müller-Schwarze, D., (eds.) *Chemical signals in vertebrates 6*, New York: Plenum.
- Hepper, P.G., 1988, The discrimination of human odour by the dog, *Perception*, 17: 549-554.
- Hilden, H., 1991, *Mathematisches Gutachten über das Geruchsspurenvergleichsverfahren der Landespolizeischule für Diensthundführer in Schloss Holte-Stukenbroch*, Unpublished paper.
- Keuringsreglement Politiepeurhond Menselijke Geur, 1992, s.l.
- King, J.E, Becker, R.F. and Markee, J.E., 1964, Studies on olfactory discrimination in dogs: Ability to detect human odour trace, *Animal Behavior*, 12: 311.
- Lindsay, R.C.L, Lea, J.A. and Fulford, J.A., 1991, Sequential lineup presentation: Technique matters, *Journal of Applied Psychology*, 76: 741-745.
- Lindsay, R.C.L, Lea, J.A., Nosworthy, G.J, Fulford, J.A, Hector, J., LeVan, V. and Seabrook, C., 1991, Biased lineups: Sequential presentation reduces the problem, *Journal of Applied Psychology*, 76: 796-802.
- Lindsay, R.C.L. and Wells, G.L., 1985, Improving eyewitness identifications from lineups: Simultaneous versus sequential lineup presentations, *Journal of Applied Psychology*, 70: 556-564.
- Malpass, R.S. and Devine, P.G., 1981, Eyewitness identification: Lineup instructions and the absence of the offender, *Journal of Applied Psychology*, 66: 482-492.
- Saks, M.J., 1993, *The unknown validity of forensic identification science*, Unpublished manuscript.
- Taslitz, A.E., 1990, Does the cold nose know? The unscientific myth of the dog scent lineup, *Hastings Law Journal*, 42: 15-134.
- Wagenaar, W.A., 1988, *Identifying Ivan: A case study in legal psychology*, New York: Harvester Wheatsheaf.
- Wagenaar, W.A., van Koppen, P.J. and Crombag, H.F.M., 1993, *Anchored narratives: The Psychology of criminal evidence*, Hemel Hempstead: Harvester Wheatsheaf.
- Wells, G.L., 1993, What do we know about eyewitness identification?, *American Psychologist*, 48: 553-571.