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1 **Scent lineups compared across eleven countries: looking for the future of a**
2 **controversial forensic technique**

3
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25 **ABSTRACT**

26 A scent lineup is generally a procedure whereby a dog’s alerting behavior is used to establish that the dog
27 detects two scents, one from a crime scene and one from a suspect, as being identical. The aim of this
28 article is to compare methodologies of using dogs in scent lineups as a means of identifying perpetrators
29 of crimes. It is hoped that this comparative approach, looking at countries where the method is currently
30 or has in the past been used, will help determine what issues should be addressed in order to assure that
31 the scent lineup will have a future as a forensic technique. Participants from eleven countries—Belgium,
32 The Czech Republic, Finland, France, Germany, Hungary, Lithuania, The Netherlands, Poland, Russia,
33 and the U.S.—completed a survey questionnaire regarding key aspects of the scent lineup procedures
34 used by the police in their countries. Although there was broad overlap on certain matters, such as the use
35 of control and zero trials, collection of decoy scents from individuals of similar gender and race as the
36 suspect, materials for holding scent, frequency of cleaning and changing stations, and use and timing of
37 rewards, there were significant differences in the degree of blindness required, who calls an alert (handler
38 or experimenter), and whether handlers can work with more than one dog. The gap between
39 recommendations and results available from the scientific literature and procedures used in police practice
40 was greater for some countries than others, even taking into account that some scientific methodologies
41 might be expensive or impractical given agency resources. The authors make recommendations about
42 how to go forward if scent lineups are to remain a valid forensic technique.

43

44 **INTRODUCTION**

45 Trained dogs working in scent lineups have, in many countries, been considered a valid identification
46 method for identifying perpetrators who left their scents at crime scenes (Bednarek 2008; Ensminger
47 2012; Prada et al. 2015). This sort of forensic technique (sometimes denominated osmology or
48 odorology) remains controversial despite its usefulness. The results of such identifications were
49 sometimes introduced as evidence in criminal courts as the primary or even the only evidence, although
50 many judges insist that scent evidence must be corroborative. Initially, testimony given by dog handlers

51 was, and in some countries still may be, accepted in courts as sufficient proof of the reliability of this
52 identification method (Gerritsen & Haak 2010).

53

54 Many of the programs were initially created by police authorities, which implemented procedures and
55 rules derived from practical experience of handlers working with dogs (Kaldenbach 1998; Bednarek
56 2008). Courts, however, began raising questions as to the reliability of a methodology based on practical
57 experience, and scent lineup procedures became a subject of scientific inquiry, particularly beginning in
58 the 1990s (Schoon & De Bruin 1994; Schoon 1996 and 1998; Jezierski et al. 2008; Marchal et al. 2016).

59

60 A positive attitude of law enforcement officials to the lineup procedure, and a need for a practical
61 identification method that could be implemented with quality controls, led to the creation of police units
62 with dedicated staff and specially trained dogs, often centralized for a country or a region of a country.
63 Unfortunately, handlers performing scent lineups have sometimes made excessive claims as to the
64 perfection of their dogs despite a sparsity of studies conducted with scientific scrutiny to support such an
65 optimistic view of the reliability of this method (Taslitz 1990; Ensminger 2012). Therefore, the technique
66 has sometimes been attacked as “junk science” and the quality of the evidence produced by the technique
67 has been called into question by lawyers, judges, and the press (Thomas 2015). Prosecutions have
68 sometimes resulted in acquittals when the evidence produced by a scent lineup appeared flawed or was
69 declared inadmissible (*Ex parte Robbins* 2016). Worse, some convictions have been overturned because
70 of questionable methods or from subsequent evidence indicating that a conviction was wrongful (Merjian
71 2009). The public image of scent identification procedures may have also suffered from reports that
72 scents of potential dissidents were stored by the East German Stasi for dogs to match with scents of
73 individuals whose scent could supposedly be found on flyers critical of the government (Makrakis 2008).

74

75 The costs involved in maintaining scent lineup programs have led police administrators and
76 governments to question whether the technique is worth the expense and trouble, and in some
77 countries scent lineups are no longer being conducted despite the belief of police authorities and
78 prosecutors that the results are useful in investigations and prosecutions (e.g. The Netherlands).
79 Since the lineup method was initially developed and improved by handlers working mainly on
80 the basis of practical experience, only occasionally with input from scientists working in the
81 area, a general lack of standardization across countries and even within many countries as to
82 almost all details of the method is not surprising. Even when scientists were involved, their
83 suggestions were often ignored or only implemented in part. The authors therefore undertook a
84 comparative analysis of programs across their respective countries to determine how much
85 variation exists in lineup methodology between countries, and to survey the current status of
86 scent lineup programs. The authors make recommendations as to what should come next if this
87 method is to continue to be used and developed.

88

89 **MATERIALS AND METHODS**

90 After preliminary communications between researchers in several countries, an initial group of
91 those participating decided to collect data on specific aspects of the programs with which the
92 participants were familiar. The desire was to gather information on how scent lineups have
93 actually been conducted, not on what best practices should be, though many of us express
94 opinions on how various aspects of our country's programs could be improved. Comparing the
95 true reliability of scent lineups across countries, taking into account the differences in
96 procedures, would be difficult, particularly due to the logistic and organizational difficulties in
97 establishing that dogs of identical or similar proficiency are being deployed in each location.

98 Such a study would also require that a large number of law enforcement agencies collaborate on
99 an international comparative experiment, which the authors agree was logistically impossible.

100

101 The lead authors therefore established a list of questions in several stages of communications
102 (made primarily by email) and collated the responses in order to describe variations and overlaps
103 between programs, and thereby built a basis for discussing the present status of and the best
104 future for the technique. In the survey, we limited comparisons to the methodological aspects of
105 the lineups, without having comparative identification results as such. Methodological details
106 were finally collected from 11 countries where the lineup identification is currently, or was in the
107 past, applied by the law enforcement agencies, which are Belgium, the Czech Republic, Finland,
108 France, Hungary, Lithuania, The Netherlands, Poland, Russia, Germany, and the U.S. Due to the
109 federal structure of some countries, e.g., the U.S. and Germany, rules and practices may differ in
110 different parts of these countries. In all countries except the U.S., responses were based on the
111 direct knowledge of the respondents of the centralized or major canine identification facilities in
112 their countries. As the lineup procedure is conducted according to unified regulations which are
113 specific for each country and no variation of the method was expected within countries, only one
114 leading unit responded, generally represented by a police expert with a good knowledge of the
115 method applied in respective country.

116

117 In the U.S., reported judicial cases provide detailed information on scent lineups and other scent
118 identification procedures actually introduced in criminal trials. Of the 50 states in the U.S., courts
119 in only 17 states have produced decisions regarding a total of approximately 170 scent
120 identification procedures, with the majority of procedures occurring in Texas and California.

121 Although data on only this limited number of lineups could be gathered from judicial decisions,
122 the handlers involved testified that procedures they conducted, generally with minimal alteration
123 of methodology, had been used in thousands of cases (*California v. Alonzo* 2008, trainer had
124 produced scent identification evidence in between 1,700 and 1,800 investigations; *Risher v.*
125 *Texas* 2006, scent lineups conducted for over 30 law enforcement agencies; *Robinson v. Texas*
126 2006, dog had worked 760 human scent identification lineups; *Pate v. Texas* 2010, handler had
127 made “thousands” of scent identifications; *U.S. v. McNiece* 1983, handler had performed over
128 1,000 scent lineups and claimed his dog had never been proven wrong, yet one of those cases
129 resulted in a wrongful conviction, as later established by DNA evidence, resulting in the State of
130 Texas awarding \$2 million damages (National Registry of Exonerations 2012)). Thus, judicial
131 opinions and orders describing scent lineup procedures collectively provide the most accurate
132 picture possible of scent lineups actually used in criminal prosecutions in the U.S.

133

134 As the responses were collected, the questions were divided into ten general categories, which
135 we believe is best displayed in a tabular format in ten tables, which are included in the Results
136 section below.

137

138 **RESULTS**

139 As expected, a general lack of international standardization of the lineup methods resulted in a great
140 heterogeneity of data and responses from different countries to particular questions formulated in the
141 questionnaire. Tables 1-10 summarize the responses provided by the participants to 29 questions.

142

143 **1. Collecting and handling of scent samples**

144 Scent samples are the essential items for the conduct of a lineup identification procedure. The properties
145 and methods of handling and storing of scent samples are crucial for the reliability of the identification.
146 Therefore, courts frequently question various details concerning how scent samples are obtained stored
147 and used in scent lineups (*California v. Alonzo* 2000).

148

149 **1.1. Materials that may hold scents**

150 Material used for collecting scent from objects or spots at crime scenes must fulfill several conditions. It
151 should be effective in absorbing scent, not react chemically with odor molecules and thereby alter the
152 odor, be easy to store over long periods without changes of odor quality or intensity, be easy to handle
153 (e.g. for multiplication of samples for testing, or be reusable for testing in the lineup), and not itself
154 contain an odor known to be aversive or attractive to dogs. In most countries, cotton pads or a mix of
155 cotton with synthetic fabrics, are used. In some countries the pads used for collecting scent samples are
156 specially manufactured for this purpose and are sealed in sterile bags. Cotton pads are easily stored in
157 sealed sterile jars, can be multiplied either by cutting into smaller pieces or by putting additional pads in
158 the jar to pick up odor by diffusion from pads previously placed in the jar.

159

160 In a number of countries the same material that is used to collect scent samples at crime scenes is also
161 used to collect scents from the suspect and the decoys for use in the lineup. In The Netherlands, Finland,
162 Belgium and in German federal state of Nordrhein-Westfalen, steel tubes are or have been used to collect
163 scents from the suspect and the decoys for use in scent lineups. The idea of using such tubes is to enable a
164 sort of self-rewarding of the dog by retrieving the target tube, which is not fixed by an electromagnet,
165 whereas the decoy tubes are fixed.

166

167 **1.2. Collecting and handling of crime scene scent samples**

168 Collecting scent at a crime scene is the first step of osmological identification. In some countries, material
169 evidence itself is collected. In other countries, scent samples are collected directly at the crime scene.

170 Material evidence, or spots or objects from which scent samples are collected, are chosen by a forensic
171 technician on suppositions concerning where a perpetrator may have left scent. Thus, scent samples may
172 be taken from weapons or tools presumed to have been used by the perpetrator or places that must have
173 been touched, e.g. handles of doors, furniture, etc. In most cases, however, it is not known if a scent
174 sample collected at the crime scene contains any odor molecules, unless fingerprints are found on the
175 object from which scent samples were taken.

176
177 Both material evidence and scent samples used for forensic investigations are considered to be evidence
178 and therefore have to be precisely labeled, described, handled and safeguarded to avoid confusion with
179 other samples, contamination with other odors, or destruction. It is not always possible to know when the
180 scent was left at the crime scene because it is not always possible to estimate exactly when the crime
181 occurred. The retention of human odor on various surfaces and materials has been the subject of research
182 that will need to be taken into consideration in developing standards for obtaining and storing scent
183 samples (Prada et al. 2011; Hudson et al. 2009).

184

185 **1.3. Collecting and handling of suspect and decoy scents.**

186 Scent samples taken from the suspects and decoys are full scents that can be collected and stored at
187 recorded times and used within a specified period to ensure similar intensity. As with crime scene scent
188 samples, scent samples from suspects and decoys used for forensic investigations must be precisely
189 labeled, described, handled and safeguarded to avoid confusion with other samples and contamination
190 with other odors. Destruction of the suspect and decoy scent samples is seldom a problem because the
191 suspect and decoy sample donors generally remain available for repeated collection of the scent samples.

192 **[Table 1 about here]**

193 **1.4. Time restrictions as to taking of scents of suspect and decoys and use in a lineup**

194 Some countries emphasize that the timing of sampling decoys should be close to the timing of sampling a
195 suspect for scent. Some countries also have time limits as to the interval between when a sample is taken

196 and when it can be used in a lineup. Primarily for organizational and logistic reasons it is usually not
197 possible to conduct lineup procedures immediately or shortly after taking scent samples, particularly those
198 obtained from crime scenes. Therefore, scent samples have to be stored until they are exposed to dogs.
199 Assuming odor molecules can diffuse from the scented material, even if stored in closed jars, or may
200 change their properties with time, a standardization of the storing time, especially setting a maximum
201 storage time, is preferable for making odors comparable in strength. Obviously, the time interval between
202 collection of a sample and using it in a lineup can be specified if such data are properly recorded. If decoy
203 samples are collected at a time that is significantly different from when a suspect's scent was collected,
204 this could represent a bias. Therefore, these two collection points should be as close as possible.

205

206 **1.5. Are stations in the lineup cleaned or replaced between trials or between dogs?**

207 Thoroughly cleaned sniffing rooms, isolated from any olfactory stimuli are generally required in
208 European programs, and stations are cleaned or replaced between dogs and sometimes between runs of
209 the same dog. Stations must generally be moved between runs of the same dog, and replaced entirely
210 between runs of different dogs.

211

212 Tops or edges of jars or containers with scent samples in the lineup may be touched by a dog's nose or
213 salivated upon, resulting in contamination or additional marking of the samples. This in turn may
214 influence the outcome of subsequent trials. Therefore, cleaning the work room and cleaning or replacing
215 the containers or scented items for each trial is widely recommended and often required. However, since
216 cleaning may create additional logistical problems, there may be a preference for replacing rather than
217 cleaning containers or stations for each trial. A station holds the jar or container with scent. Some
218 osmological laboratories also shift stations between consecutive trials. This, along with procedures for
219 cleaning or replacing jars or containers, can assure that the order of the stations as well as the order of the
220 containers is random. In other laboratories, the stations (which may be fixed to the floor) remain in place
221 and only the jar or container's position is randomized.

222

223 **2. Characteristics of decoys**

224 Decoys are scents from individuals other than the suspect. Obtaining and proper use of decoy scents is
225 necessary to ensure unbiased indications can be made by dogs in a lineup. The purpose of using decoys in
226 the lineup is to demonstrate that the dogs discriminate scents of different humans and thus a matching of
227 scents can be accomplished. Using decoys increases the reliability and validity of identification.
228 Theoretically, the more decoys (and hence stations) in the lineup, the lower is the probability that
229 indications of the target sample are made by chance.

230 **[Table 2 about here]**

231 **2.1. Requirements on use of decoy scents in lineup**

232 Decoy scents are used in all countries surveyed, though the number of decoys varies considerably,
233 ranging from 4 up to 12 in a single trial. As a matter of practicality the number of decoys may be limited
234 in part on the size of the sniffing room which has to allow for enough distance between stations so as to
235 avoid confusion in assessing which station is actually being indicated by a dog. Care should also be taken
236 to avoid possible effects of scent plumes drifting over one or more neighboring stations, which is most
237 likely to happen when the stations are too close to each other and when there is any movement of air in
238 the room.

239

240 **2.2. Do decoy scents have to be taken from individuals who are similar to the suspect in sex, age,** 241 **occupation, or other specified criteria?**

242 Theoretically, the more the decoy scents are similar to that of the suspect with regard to gender, age,
243 occupation, and other criteria, the greater certainty that a dog has been able to distinguish an individually
244 unique, genetically determined and unchangeable component of the suspect's scent. Thus, using decoys
245 that are similar to the suspect increases the reliability of the identification of an individual as a
246 perpetrator. (See Schoon et al. 2009; Curran et al. 2007). Most countries require or prefer that decoy
247 scents be taken from individuals of the same gender and race or ethnicity, and often of similar age. Other

248 criteria as to similarity of scents may include the profession of individuals sampled, where they live,
249 diseases they have, and medications they use.

250

251 **2.3. Can decoys be police officers?**

252 Often there is a practical problem in collecting decoy samples from a sufficient number of individuals,
253 though decoys cannot be police officers in the Czech Republic and only exceptionally in several other
254 countries. Since police officers are readily available as scent donors, there may be a tendency to collect
255 decoy samples from them. It cannot always be determined whether the police officers from whom decoy
256 scent samples have been taken were alien or familiar to the dogs used in a scent lineup. If the dogs are
257 familiar with scents of police officers used as decoys, the dogs may show a tendency to indicate a novel
258 and/or distinctive scent of a perpetrator, independently of matching or not matching to the scent collected
259 on the crime scene. This, in consequence, increases the likelihood of a false indication to an innocent
260 suspect.

261

262 **2.4. Is there a requirement that all scents, including decoys, be novel (unfamiliar) to dogs during** 263 **training or testing (certification) stages, or in actual judicial trials?**

264 In literature on scent lineups, concerns arise that dogs may memorize individual odor samples, even if
265 large numbers are used during training or in judicial trials. In cancer detecting dogs this may have
266 consequences in indicating by dogs the memorized pattern samples that were frequently used during
267 training, rather than generalization on a common odor of cancer markers (Elliker et al. 2014). In scent
268 lineups used forensically for human identification purposes, frequent use of the same samples as decoys
269 during the training stages, or during certification or in judicial trials, may result in a so-called pseudo-
270 match-to-sample (Hale 2017). Therefore, repetition of the use of samples from the same donor should be
271 avoided. Ideally, novel samples (donors) should be used for each trial. However, requirements as to the
272 scent samples used as decoys (Table 2) make the availability of novel decoy samples in numbers
273 sufficient for each procedure, including control trials, practically impossible and thus necessitate re-use of

274 some samples. The responses to the question 2.4. indicate that the osmology experts are aware of the
275 problem of a systematic use of novel samples, even if there are no formal requirements but only
276 recommendations in this area, but re-use of samples is sometimes inevitable. Out of 11 countries
277 surveyed, in 7 countries only novel samples are used both in training, certification, and judicial trials, in 2
278 countries novel samples are combined with those re-used, in 1 country samples are frequently re-used.
279 From 1 country no information was available, probably due to a failure to distinguish between novel and
280 re-used scent samples.

281

282 **3. Control and disqualification trials**

283 The goal of control trials is to check (1) the disposition of the dog and its motivation for olfactory work
284 before further tests are performed, and (2) whether the scent of a suspect is, for any reason, “attractive” to
285 a dog, i.e. might be indicated regardless of actual matching or not matching to a reference or evidential
286 scent. Control trials are those in which the target odor sample placed in the lineup and the sample given to
287 the dog to sniff at the starting point of the lineup (matching scents) are from the same person. For an
288 official trial, that person cannot have been involved in the forensic investigation and must be verified as
289 having never been present at the crime scene. Other scents in control trials are decoys, including
290 sometimes the scent of the suspect who will be subsequently tested in an official identification trial. Most
291 European countries surveyed employ control trials, generally just before a dog is used in an identification
292 trial. Such trials are rarely mentioned in U.S. cases and have never been judicially required. All European
293 countries surveyed except Belgium employ control trials before a dog is used in identification trials.

294 **[Table 3 about here]**

295 **3.1. Number of disqualifying control trials**

296 A dog can be used in official identification trials if it successfully completed control trials. The number of
297 control trials varies among respondent countries. In some countries, e.g. The Netherlands and Finland,
298 there is a fixed pattern of applying control trials, whereas in other countries, e.g. Poland, it is up to the
299 osmology expert to determine how many control trials should be conducted for qualification or

300 disqualification of the dog before official identification trials. In some countries, e.g. the U.S., there is no
301 requirement for control trials, though some handlers conduct them. Generally, the number of control trials
302 has to strike a balance between several experimental needs: (1) checking of the dog's disposition for work
303 on a particular day, (2) not making the dog bored or tired because of the length of the activity, and (3)
304 leaving sufficient laboratory time for all trials to be conducted according to the identification protocol.

305

306 **3.2. Negative check (zero) trial requirement (as control or within identification trials)**

307 In a negative check or zero trial, there is no item in the lineup that matches the scent provided the dog
308 before it runs the lineup. Such a negative check might be one of the control trials or might be performed
309 in between the identification trials. Zero trials are considered to be more difficult for dogs than normal
310 control trials since they require a dog to refrain from indicating any sample, which can nevertheless
311 happen, for instance, if the dog is overly motivated to earn a reward. However, zero trials increase the
312 certainty that the dog will not indicate at any accidental station when there is no matching sample in the
313 lineup. Such trials are sometimes used in European practice, though there is no requirement in the Czech
314 Republic or Russia, and in The Netherlands and Finland such a control is only part of the certification
315 process. There is no requirement for such trials in the U.S., though such trials are sometimes performed.

316

317 **3.3. Time intervals used between trials**

318 If matching consecutive pairs of scents occurs too quickly, short-term olfactory memory may cause the
319 dog to remember the previously sniffed scents and the dog may tend to duplicate a prior response and thus
320 fail to match subsequent scents correctly. Although separating stations by greater distances may help
321 slightly, rooms where trials are conducted are generally too small for this to be an ideal solution, so it is
322 best to build in a delay of several minutes between trials. The temporal gap between trials is also
323 important in (1) allowing time for the dog to receive award, (2) letting the dog understand that one trial is
324 over.

325

326 **4. Experimental setup of the lineup identification**

327 Experimental setup may influence the outcome of the identification procedure and affect its reliability.
328 Unfortunately there is little experimental data comparing variations in such setups (Schoon 1996, 1997,
329 1998).

330 **[Table 4 about here]**

331 **4.1. Number of stations in a trial**

332 Countries vary from 3 to 8 stations in a lineup, though circles of 10 and 12 stations are used in Poland and
333 Russia. Theoretically, the greater the number of stations in the lineup, and the fewer holding target
334 samples, the lower the probability that a correct hit will occur by chance alone. However, there are some
335 limitations as to the optimum number of stations in the lineup, such as available space in the sniffing
336 room for proper distances between stations. Another question concerns how many odors a dog may keep
337 in memory while working a lineup, so that the longer the lineup, the more odors the dog sniffs, potentially
338 resulting in the dog no longer holding the scent it is supposed to match in memory. Although the
339 question of how many odors a dog can be trained to identify has been a research subject (Williams &
340 Johnston 2002, concluding dogs could be trained to identify at least 10 odors; Elliker et al. 2014, 12 odors
341 for at least one dog), the significance of canine working memory in lineup situations requires further
342 study. Also, dogs may omit some stations if there are too many of them, which introduces another
343 difficulty for statistical evaluation.

344

345 **4.2. Number of trials before an identification can be used as evidence in a criminal prosecution**

346 There are generally requirements for a number of identification trials before evidence can be used in a
347 prosecution, though this has not been true in the U.S. The number of official trials that may be conducted
348 may be limited by the number of scent samples available for a trial, particularly if procedures specify that
349 scent samples are to be exchanged between every trial and every dog.

350

351 If dogs are rewarded during control trials, where the expert knows which target sample is correct, this
352 may cause problems in official trials where the expert does not know if there is an actual matching of a
353 suspect's scent to the evidential scent collected at the crime scene. This may lead to the situation where a
354 dog, frustrated as a result of not obtaining a reward, begins to make false alerts.

355

356 **4.3. Number of dogs used in an official identification**

357 The number of dogs for an official identification varies from 1 to 3—in very rare cases, 4—depending on
358 the country and local logistical capabilities. Some countries require that more than 1 dog reach the same
359 result before a scent lineup can be considered in a prosecution. Theoretically the more dogs used and the
360 more that indicate identically, the more statistically reliable is the lineup identification, even if the dogs
361 are not necessarily responding to the same set of odorants from an individual. However, when more dogs
362 are used in an official test, certain issues should be taken into account. First, such an increase in reliability
363 is only true if the dogs are working independently from each other, meaning that they are working on
364 physically different scent samples in the lineup to prevent any cues from an earlier dog indicating on a
365 particular sample. Second, dogs leave odor traces on the floor and in ambient air in the sniffing room,
366 which may interest or distract dogs used in subsequent tests (especially if males and females are used in
367 sequences) even though they were previously familiarized with these scents during training. Therefore, a
368 thorough removal of all odor traces in the sniffing room between each dog is recommended. Third,
369 although all dogs are formally certified, their performance in a lineup may differ. When more dogs are
370 used and there are discrepancies between their indications, it is difficult to justify simply accepting the
371 results of better dogs and ignoring the results of dogs found over time to be poorer performers.

372

373 **5. Alerting of dogs**

374 Since a dog's alert may be interpreted as matching scent found at a crime scene to scent of a suspect,
375 which practically means an identification of the perpetrator of a crime, the certainty that the dog has in
376 fact alerted faultlessly becomes crucial in the forensic and judicial use of scent identification procedures.

377 **[Table 5 about here]**

378 **5.1. Who calls an alert?**

379 Alerts can be called by handlers in some countries, e.g., Hungary and the U.S., but must be called by
380 experimenters or technicians in others. Alerting by a dog should be overt and readable to anyone but some
381 dogs may have unique alerting behaviors readable only to their handlers, while other observers may have
382 doubts as to whether the dog is alerting or just hesitating. Therefore, the question of who calls alert may
383 be important for the outcome of the identification procedure. It is, in any case, essential that the person
384 calling the alert be unaware of the position of the suspect's odor since that may bias his judgement.

385

386 **5.2. Requirement that all stations be sniffed (even after correct alert)**

387 Some countries require that all stations be sniffed in the running of a lineup but others do not. During
388 training dogs are taught to sniff all stations in a lineup. However, when dogs become familiar with a
389 routine, they may develop a habit of not sniffing all stations systematically, and some are likely to stop
390 after indicating, particularly if rewarded.

391

392 **5.3. Is video-recording of official trials required or standard?**

393 Some courts require evidence that a lineup identification be made in accordance with state-of-the-art
394 techniques so as to eliminate doubt that the suspect's scent matches the scent found at the crime scene.
395 Some countries videotape procedures regularly, some only for more serious offenses, and some only
396 when evidence is being collected for specific use in a criminal trial. In some countries, defense lawyers
397 can ask to view videotapes of official identifications introduced at trial. Analysis of video-recordings may
398 provide additional information as to the sniffing and alerting styles of dogs and may be a useful material
399 for scientific studies. Clear alerts on videotapes may be particularly persuasive in judicial settings.

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6. Degree of blindness

Although scientific researchers place a premium on having as high a degree of blindness as possible, practical implementation of the scent lineup procedure by police departments has resulted in considerable variation on the blindness required in the conduct of scent lineups.

[Table 6 about here]

6.1. Degree of blindness required as to the placement of the target scent (i.e., whether the handler must be blind, whether an experimenter or technician within sight of the dog or the handler must be blind, and whether any other participant present during a lineup must be blind)

There are variations in the degree of blindness required for a scent lineup, though only in the Czech Republic, Hungary and partly in the U.S. may the handler know where the target sample is placed. Some countries (The Netherlands, Poland and Russia) require double-blindness, such that an experimenter or technician who knows where the target is placed cannot be within view of the handler or dog running the lineup or anyone else present in the room where the dog is running the lineup. In the remaining countries the questionnaires reported the degree of blindness which can be considered as single-blind, meaning that only the dog handler is truly blind, while the presence of other persons (experimenter and/or assistant), who are aware of the position of the target odor sample, is allowed within view of the handler and the dog.

Dogs have adapted behaviors to bring them close to humans over the course of their domestication, and thus have considerable skill in reacting to commands and even subtle cues given by their human caretakers (Miklosi et al. 2005; Lit et al. 2011). This ability is advantageous in many tasks of working dogs. However, in some specific tasks, such as the lineup procedure, where the dog has to take a decision on its own whether to perform or refrain from performing a specific task, a dog's looking for support or cues from humans calls into question the integrity of the dog's responses to odor samples. Ultimately, in the lineup procedure, dogs have to match odors whose status as matching or not matching are unknown to

426 either the osmology expert or the dog handler. However, during the training or control trials the matching
427 status of odors is known to both the expert supervising the trials and to the dog handler (no blindness), or
428 only to the expert but not to the handler (single-blind trials), or to neither of them (double-blind). No
429 blindness is useful during the initial phase of training when an immediate reward for obeying a command
430 to indicate the target sample is necessary. Single-blind trials are useful for control trials or for
431 maintenance training where the time interval between the dog's correct response and the reward must be
432 short. In such trials, the experimenter, who knows whether the dog's response was correct or false, may
433 give an acoustic or visual signal so that the dog can be rewarded.

434

435 In double-blind trials, neither the experimenter nor the dog handler nor any person within the range of the
436 dog's senses is aware of the matching status of the tested odor samples. True double-blind trials are used
437 during official testing of the suspect's odor sample for matching it to the sample collected at the crime
438 scene. In such a trial no rewarding of a dog for indication of the target sample is appropriate since no one
439 knows the matching status of the odor sample.

440

441 **6.2. Must an experimenter who is aware of the position of the target sample be totally isolated from**
442 **visual or auditory contact with the handler and the dog?**

443 Dogs may respond to cues of individuals within their view other than their handlers (Buytendijk 1936).
444 Courts have occasionally recognized that cueing could come from persons, other than the handler,
445 watching a scent lineup who knew the location of a target (*California v. White* 2009). Sometimes the
446 distinction between double-blind and single-blind trials is vague, however. If, for instance, the technician
447 or the experimenter is totally isolated from any contact with the handler and the dog, and the handler is
448 unaware of the position of the target sample, it could be assumed that such tests are double-blind.

449

450 **6.3. Means by which observers and handlers communicate, including visual or acoustic signals, a**
451 **clicker, etc.**

452 Under a single-blind procedure there is a technical issue of how the signal confirming that the indication
453 of the dog was correct or false should be given so as to reward or not reward the dog properly. The signal
454 should be easy to operate from outside the sniffing room and audible or visible to the handler. Usually the
455 signal is given only after a correct indication by the dog and a lack of signal means that the indication was
456 false. Alternatively, another signal (e.g. another color of the lamp or another tone of an acoustic signal)
457 may be given to differentiate a correct indication from a false alert. After consistent use of a signal
458 system, a dog may become conditioned to particular signals and, in some cases, the acoustic signal itself
459 may then be perceived by the dog as a reward. The dog may also not sniff additional stations after this
460 point, as discussed above.

461

462 **7. Handling of dogs during trials**

463 The manner of handling dogs during trials and in their kennels, as well as during daily routines, may
464 influence the motivation to work and their effectiveness in performing tasks. It must be kept in mind that
465 dogs work a scent lineup for a reward, i.e., for a positive reinforcement. Dogs should enter the sniffing
466 room willingly in expectation of having an opportunity to fulfill their search and prey drives. Proper
467 handling of dogs may increase their motivation for sniffing, especially in the sniffing room.

468 **[Table 7 about here]**

469 **7.1. Rewards that may be used for the dog, including treats, toys, etc.**

470 Rewards appealing to dogs vary with their preferences. In contrast to drug or explosives detection dogs,
471 where the dogs should pay no attention to food, in the lineup procedure dogs are sometimes rewarded
472 with treats. This creates a risk of contaminating lineup material, particularly in U.S. scent lineups where
473 the majority of such lineups have been conducted using bloodhounds. For some dogs with a strong prey
474 drive, a toy to throw to be retrieved may provide a greater motivation than a treat. However, throwing a
475 toy in the sniffing room may be inconvenient because a running dog could damage stations in the lineup
476 or hurt itself. Often there is a combination of a treat reward for a correct indication and a toy at the end of
477 the test to encourage the dog willingly to enter the sniffing room for the next test. The degree to which

478 play is used should take into account the dog's age and whether it expended energy playing before the test
479 began.

480

481 **7.2. Timing of rewards**

482 Rewards are generally offered during the course of procedures, such as when there is a correct response,
483 often occurring after a clicker sound is made by an experimenter or technician to notify the handler to
484 provide a reward, but also sometimes at the end of work. Timing of rewards should follow precisely the
485 right moment and not involve a long a delay such that the dog may not associate the reward with the
486 correct reaction (Yamamoto et al. 2009; Hall and Wynne 2016; Minhinnick 2016). Although delayed
487 rewarding is well known in practice, in order not to confuse the dogs most rewarding should directly
488 follow a correct indication in the lineup. The sniffing of scent samples in the lineup takes only seconds
489 and an imprecise rewarding technique may confuse the dog (see Browne et al. 2013, Browne 2014,
490 finding that a delay in reinforcement as short as 1 second can impair learning).

491

492 **8. Dog characteristics and training**

493 The qualities of dogs in terms of their trainability, reliability, calmness, ability to focus on the task
494 (attentiveness), motivation, stamina, good health, and ease of handling are crucial for the lineup
495 procedure.

496 **[Table 8 about here]**

497 **8.1. Breed preferences for scent lineups**

498 One of the most frequently asked questions concerns which breed is most suitable for working in the
499 lineup. There is no definite answer to this question since not only must breed characteristics be taken into
500 account but also individual predispositions of dogs. Some handlers argue that breeds known for their
501 excellent sense of smell (e.g. bloodhounds, particularly in the U.S.), though it may be doubted whether
502 dogs that work well outside (most judicially reported U.S. lineups were conducted outdoors, often near
503 crime scenes or where tracking led to a suspect) are actually the best candidates for scent lineups

504 generally conducted inside. Work in the lineup is very different from tracking in terrain, and breeds
505 specialized in tracking can quickly become bored with the monotonous work of the lineup and thus
506 become useless. Breed preferences sometimes depend on country traditions and handlers' preferences as
507 well as on availability of particular breeds for police work. Although there is no consensus, German
508 shepherds and mixed shepherd breeds predominate across a number of countries.

509

510 **8.2. Age requirements for dogs performing scent lineups**

511 Dogs generally begin working after about a year of training, but there is considerable variation between
512 countries as to the length of training programs. Dogs are sometimes required to retire at about 10 years of
513 age. Lineup work requires focusing the dog on the task and the necessity of repeating the trial several
514 times, which requires a strong motivation to earn a reward but to work without overly active and chaotic
515 movement. Therefore, very young dogs are not appropriate, but rather dogs at least a year and a half old
516 with a stable temperament and character are preferred. As the work in the lineup does not require a
517 special physical endurance, even older dogs may work well.

518

519 **8.3. Period of training before dogs can make an official identification or certification requirement**

520 Since results of canine identification in the lineup are often presented as evidence in courts, attention has
521 to be paid to qualification, sometimes involving a formal certification, of dogs used. The duration of the
522 training before a dog is considered ready for official identifications depends on the skills of the dog and
523 the handler as well as on the logistical and organizational issues. Retesting or recertification is common at
524 intervals or upon the perceived decline in a dog's abilities.

525

526 **9. Osmology expert and handler qualifications**

527 Qualification discussions sometimes consider only the requirements for the dog, but it is equally
528 important that persons involved in scent lineup procedures receive adequate training. An osmology expert
529 and dog handler should not only possess knowledge and skills on canine training and behavior, but

530 preferably have at least basic qualifications in forensic techniques because improper handling and use of
531 scent samples as forensic material may affect the usefulness of the outcome of lineup procedures as
532 evidence from judicial point of view.

533 **[Table 9 about here]**

534 **9.1. Qualification requirements for handlers**

535 Handlers must generally be trained in specialized facilities before being able to produce official lineup
536 evidence. As with the other forensic procedures, experts in charge of conducting trials and authorized to
537 produce a final identification outcome, as well as the dog handlers who lead and reward the dogs, should
538 have proper and formally documented qualifications to perform their jobs.

539

540 **9.2. Can handlers have more than one dog?**

541 Handlers in most countries work with more than one dog. It is well known that between the dog and the
542 handler a special bond is created during training and deployment. It is also known that there must be a fit
543 in temperament and character between the dog and the handler. Also, to keep the dog in good physical
544 and mental condition, substantial time and effort is demanded of both the dog and the handler. Therefore,
545 as a best practice, a team of one dog paired with one handler is probably optimal. However, sometimes
546 for organizational reasons, a handler may work with two or more dogs.

547

548 **9.3. Frequency and length of training sessions after teams begin performing scent lineups**

549 Daily and weekly training sessions are designed to maintain proficiency. For maintaining a good working
550 performance, candidate dogs for lineup identifications require a well-designed initial training regimen,
551 while certified dogs require systematic sustaining training and exercising. The frequency and length of
552 training session may depend on the decision of the handler or on the official regulations for dogs
553 performing forensic tasks.

554

555 **10. Measures undertaken to decrease judicial skepticism or public mistrust as to reliability and**
556 **validity of scent lineups in criminal prosecutions**

557 Since identification of perpetrators by dogs is often presented as evidence in courts, it is obvious that
558 lawyers will inquire into the reliability of scent lineups, and how the evidential or diagnostic value of the
559 procedure can be quantified or characterized. Especially in cases of a positive identification by dogs,
560 where there is a minimal amount of other judicially recognized evidence, skepticism and mistrust has
561 been increasingly expressed by some judges.

562 **[Table 10 about here]**

563 **10.1. Must the probability of a correct indication by chance be estimated, or is such an estimate**
564 **standard?**

565 When a dog has to match one of scent samples presented in a lineup, there is a certain probability of
566 correct hits of the target sample occurring by chance alone. The lower this probability is the more valid
567 are the results obtained. The probability of correct hits by chance depends of the number of scents in the
568 lineup, the number of target samples, the number of trials, and the number of dogs. This probability also
569 depends on how correct indications are calculated. For instance, if a correct hit is considered as a choice
570 of one target out of n samples sniffed in the lineup, the probability of correct hits by chance in one trial is
571 $1/n$, but if a correct hit is considered as a single yes/no decision of the dog towards each sample sniffed in
572 the lineup, this probability is 50%.

573

574 The following formula has been proposed by Koziol & Sutowski (1998) and includes factorials for
575 calculation of the theoretical probability of correct hits by chance, taking into account the number of
576 samples in the lineup, the number of targets, of dogs and of trials:

577
$$P = [k!(n - k)! / n!]^{lm}$$

578 where:

579 P = probability of correct indication by chance in repeating trials several times with several dogs

580 k = number of target samples in the lineup

581 n = number of stands in the lineup

582 ! = factorial (thus, if $n = 6$, $6! = 6 \times 5 \times 4 \times 3 \times 2 \times 1 = 720$)

583 l = number of dogs used

584 m = number of trials conducted

585

586 Courts are frequently interested in whether there is a significant likelihood that a dog's indication, even if

587 correct, was a "lucky guess." There are limitations to such a formula because consecutive scent lineup

588 trials are not fully independent from each other since the dogs may learn from one trial to another which

589 of the samples in the lineup are target or decoy samples. Also, if the same scent samples are used for more

590 than one dog, an earlier alert may have left cues on a sample that a later dog could respond to, meaning

591 that the lineups are not independent.

592

593 **10.2. Have experimental studies been undertaken by independent scientific institutions to assess the**
594 **validity and reliability of scent lineup identifications?**

595 Lineup identifications are performed primarily by police officers who have specialized in canine training

596 and handling. However, in lineup procedures in general there has been a lack of scientific scrutiny,

597 without proper statistical analysis or any inquiry into the validity of procedures used by handlers.

598 Therefore, for forensic and judicial acceptance of the lineup procedure, assessment of a procedure should

599 involve independent scientific analysis with respected scientific tools. In some countries, such scientific

600 studies have been undertaken in independent scientific institutions and published in peer-reviewed

601 scientific journals (Schoon 1996, 1997, 1998; Jezierski et al 2008, 2010; Vypelova et al. 2014), while in

602 others either no such studies have been conducted or any that were became parts of technical reports used

603 for vocational training, mostly lacking proper statistical proofs showing the significance of results. It

604 seems, however, that the results of scientific studies published in peer-reviewed international journals

605 were not sufficiently disseminated in law enforcement forces and taken into consideration by officers in

606 charge of osmology procedures, or even by lawyers in courts.

607

608 **To answer questions** by judges about the reliability of the lineup identifications, Schoon (1998) proposed

609 two parameters. The first was the *diagnostic ratio of positive identification*, defined as a ratio of percent

610 of correct identifications in suspect = perpetrator cases to percent of false identifications in suspect ≠
611 perpetrator cases. This ratio was experimentally estimated as high as 13.6, meaning that there could be
612 one false identification in every 13-14 positive identifications. A false identification may result in a false
613 accusation of the suspect, if the lineup identification is taken as the only evidence. The second parameter
614 proposed by Schoon (1998) was the *diagnostic ratio of negative identification*, defined as the ratio of
615 percent of correct non-identifications in suspect ≠ perpetrator cases to percent of misses in suspect =
616 perpetrator cases. The experimentally obtained diagnostic ratio of negative identification amounted to
617 2.6, which can be interpreted as one not identified perpetrator (in consequence falsely absolved by scent
618 lineup evidence) in every 2 to 3 negative identifications using a scent lineup.

619

620 However, significant individual differences in dogs' performances in operant conditioning during match-
621 to-sample trials were found by Jezierski et al. (2008). Additionally, the style and time of sniffing the scent
622 samples to be matched, and the number of stations sniffed or omitted were found to influence the
623 percentage of false alerts and false negative indications.

624

625 As an alternative to the traditional scent lineup consisting of several scent samples arranged in a line, a
626 different design using scented steel tubes and following an odd-even paradigm was examined by Schoon
627 (1997). Instead of comparing several samples in the lineup, dogs had to compare "odd," when the scent
628 presented to the dog at the starting point was different from the one placed on a platform, or "even," when
629 the scent presented at the starting point was identical with that on the platform. The other station on the
630 platform was always blank. If the trial was "odd" the dog was trained to go to the blank tube and respond
631 to this blank tube. It was found that, in comparison to the customary match-to-sample design, the new
632 design produced a comparable level of matching "even" scents but the level of non-matching "odd"
633 comparisons was substantially higher. This meant there were fewer false alerts, so it was concluded that
634 this new design would be more reliable. However, this proposed design has never been implemented in
635 police osmology praxis.

636

637 More recently, it was shown by Marchal et al. (2016) that, due a rigorous procedure and continuous
638 training, a high sensitivity of 70% and 100% specificity, i.e. with no false alerts over 200 trials, could be
639 achieved. Interestingly, in this study, sensitivity increased with the number of trials. The authors believed
640 their results could convince law enforcement authorities not to withdraw the identification of humans on
641 the basis of individual scent as official forensic evidence. It has to be noted, however, that in contrast to
642 the claims of Marchal et al.(2016), a study by Jezierski et al. (2010) found that trained dogs, though easily
643 learning to perform operant conditioning responses in the scent lineup, displayed no significant
644 improvement of identification accuracy, both within particular training phases and during the working
645 phase, despite becoming more experienced as they worked.

646

647 In some countries studies have been conducted that were focused not specifically on demonstrating the
648 reliability of the scent lineup, but on properties of human individual odor that may be of importance for
649 scent lineups as a forensic technique. For example, the results obtained by Vypelova et al. (2014) suggest
650 the existence of human odor fallout, whereby a human scent trace is left by humans even if they do not
651 touch an object. (See also Prada et al. 2011 regarding scent collection by placing a sorbent material in
652 contact with an item that has been in contact with an individual.) This finding, if confirmed, would be of
653 importance for extending of application of the scent lineup as a forensic technique. One recent paper
654 suggests that the effectiveness of scent lineups is compromised when certain training techniques are
655 employed with dogs, though the paper contained no experimental evidence that the conceptual framework
656 proposed would lead to better results in canine scent lineups (Hale 2017).

657

658 Generally, it is difficult to determine whether the canine level of performance makes this evidence
659 appropriately admissible in criminal prosecutions (Helton 2009, Ensminger 2016). Despite a number of
660 studies examining canine detection performance on a diverse array of tasks, it is difficult to make a
661 general comment about detection reliability. This is due to three problems listed by Helton (2009): (1), a

662 lack of uniformity in reporting performance, (2), a lack of uniformity in testing conditions, and (3), a lack
663 of training information for dogs used in most studies. The results of the present survey generally confirm
664 a lack of uniformity of the lineup procedure among countries from which responses were obtained.

665

666 **10.3. Has there been a decline or cessation of the use of scent lineups in police practice or judicial**
667 **acceptance?**

668 The use of scent lineups is either declining or has been terminated in a number of countries. In Germany,
669 scent lineup identification is carried out, if at all, by the police forces of the federal states. Due to the
670 federal structure of Germany with 16 federal states, the design of police procedures is a matter for the
671 states, with each state determining how the police service dog system is structured. For several years, the
672 lineup procedure is no longer in use and the method was used in the past in two federal states only. For
673 example, the federal state of Nordrhein-Westfalen had regulations between 1988 and 2011 as to the use of
674 the police in the scent lineup procedure. Also, from 1989 to 2012 the police forces in the federal state of
675 Baden-Wuerttemberg used a similar scent lineup procedure. In the past the scent lineup procedure was
676 used in the former GDR according to Methodological Guide on the use of scent differentiation in the fight
677 against crime, issued by the Ministry of Interior. Currently there are no special regulations for the use of
678 scent lineup. On the other hand, there are efforts to reintroduce the lineup procedure again. In Schleswig-
679 Holstein, for example, two dogs are specially trained and have already been used for criminal
680 investigations.

681

682 In The Netherlands, the lineup procedure, despite of being well based on high quality scientific studies, is
683 no longer used by police. The main reason was a lack of strict application of the prescribed methodology
684 and failure to demonstrate the required double-blind character of the procedure. This fact was revealed in
685 criminal cases which caused strong mistrust as to the reliability of the procedure and resulted in official
686 withdrawal of scent lineups from forensic practice.

687

688 Scent lineups have been performed in Poland since 1962 (Bednarek 2008). The technique developed
689 rapidly in police work during the period from 1997 to 2005, with dedicated laboratories, training of many
690 dogs and staff, conduct of special workshops for osmology experts, and publishing of experimental
691 results and discussion articles in police and law journals. In 1998 there were 36 police osmological
692 laboratories deploying approximately 118 certified dogs and 936 identification procedures for courts were
693 performed. Due to the verification process and quality control, the number of osmological laboratories
694 decreased to 16 in 2005, performing 1767 procedures. In 2015 the number of laboratories was reduced to
695 6, but doubts and controversies that emerged as to the reliability of the procedure, especially as evidence
696 for courts, resulted in a decline in the use of this procedure, although it is still performed (Dzierzanowska
697 2016).

698

699 In the U.S., scent lineups as performed have been criticized as inadequate to produce judicial evidence
700 almost since the beginning of their intense usage (Taslitz 1990). Even with the development of more
701 advanced techniques in Europe, U.S. procedures remained primitive and well outside such advanced
702 techniques, despite the occasional efforts of respected scientists and even FBI agents to portray them as
703 reliable (*Texas v. Dominguez 2011*; *California v. Alonzo 2008*). No court (as of the end of 2018) has
704 issued a decision regarding a scent lineup that was actually performed from 2012 on. Cases on specific
705 handlers began to appear in the 1980s and 1990s, but most cases were issued between 2000 and 2011.
706 Due to a combination of (1) discrepancies between handler claims for the perfection of their dogs and
707 actual results, (2) overturned convictions, and (3) judicial skepticism, with many lawyers now calling
708 scent lineups a “junk science” (Thomas 2015), the future of scent lineups in the U.S. is in considerable
709 doubt. The leading legal critic of scent lineups acknowledged in 2013 that the adoption of European
710 techniques, if widely accepted in the scientific community, could lead to U.S. scent lineups becoming an
711 acceptable source of judicial evidence (Taslitz 2013).

712

713 **DISCUSSION**

714 Scent lineup procedures have been accepted by courts in the countries surveyed, though some of their
715 judicial systems no longer accept such evidence or have considerably reduced the instances where such
716 evidence is allowed in court. There is substantial overlap between most European programs on many
717 aspects of scent lineups, with divergence on certain other aspects. There is a greater degree of separation
718 of U.S. practice from European practice. The approaches in Europe generally follow a similar pattern,
719 though there are significant differences on specific aspects of how scent lineups are conducted. In the
720 U.S., handlers who perform scent lineups adapted their initial approaches from tracking work, only
721 occasionally and usually minimally incorporating concepts from the research literature. Nevertheless,
722 U.S. lineup procedures have sometimes been declared reliable by researchers who have studied scent
723 identification (e.g., *Texas v. Dominguez* 2011; *California v. White* 2013).

724

725 For all countries surveyed here except the U.S., questionnaires could be answered by describing standard
726 practices of specialized, and generally centralized, police units where scent lineups are conducted. Those
727 units establish standards for training dogs and personnel, as well as procedures by which data is produced
728 and evaluated before being provided to prosecutors for use in criminal trials. Magistrates generally have
729 the authority to determine whether the evidence proffered will be admitted in the determination of the
730 guilt or innocence of a defendant.

731

732 In the U.S., scent lineups as employed in criminal investigations and prosecutions are not conducted by a
733 centralized police unit but rather by individual handlers who are either employed by local police
734 departments or independent contractors who work on a regular or intermittent basis with a police
735 department or other law enforcement authority. Prosecutors then determine whether the scent lineup
736 results will be proffered as evidence during a trial, though judges may find various grounds for precluding
737 such evidence from being heard by a jury or considered by the judge acting as the trier of fact without a
738 jury. If the evidence is accepted by a court, the judge may issue an opinion or order in which he or she
739 discusses the nature of the scent lineup evidence produced at trial.

740

741 Also, for all countries except the U.S., scent lineups are usually conducted in special isolated and
742 regularly cleaned rooms with standardized procedures. In the U.S., in contrast, the vast majority of
743 judicial cases where the location of a scent lineup was specified were outdoors in places like parking lots
744 (e.g., *California v. Willis* 2004) and open fields (though sometimes this is not specifically stated but rather
745 inferred from statements in an opinion about wind direction or weather conditions or the fact that joggers
746 might have been a distraction for the dog). When conducted indoors, the location was often a room in a
747 police station or a courtroom (e.g., *Ramos v. Florida* 1982). The reason lineups have so often been
748 conducted outdoors is that tracking dogs (particularly bloodhounds) were often used in scent lineups,
749 sometimes directly or soon after performing a tracking function (e.g., *Brooks v. Colorado* 1999;
750 *California v. Demirdjian* 2003). In 20 reported cases involving scent lineups, the dog or dogs used
751 performed an additional function in the investigation, generally tracking.

752

753 A further difference between the European countries surveyed here and the U.S. is that in Europe scent
754 lineups are usually conducted with scents on specialized pads or tubes, held in jars or clamped to
755 platforms that are frequently cleaned and in rooms that are also frequently cleaned. In the U.S., the item
756 sniffed is not always specified in judicial cases, but where this has been indicated, 26% were lineups of
757 persons, 17% were lineups of crime scene objects, and 57% were lineups using scent pads or other items
758 on which scent from a crime scene had been placed by rubbing or some other means. Lineups of persons
759 or objects have been reported in judicial cases even in the last 15 years. Where scent lineups use cotton
760 pads or other objects, it can seldom be said that the lineup was conducted in an environment that is free of
761 other olfactory stimuli, or in an area that had been, or could be, cleaned at all. Various U.S.
762 organizations, including SWGDOG (Scientific Working Group on Dog and Orthogonal detector
763 Guidelines), has published “recommended best practice general guidelines for training, certification, and
764 documentation pertaining to canines trained in conducting scent identification lineups.” (SWGDOG SC 9:
765 Human Scent Dogs (Statement of Purpose). Although not specifically providing protocols for

766 investigations, the training and certification recommendations contain elements of certain European
767 practices. (The SWGDOG organization has been replaced by the Dogs and Sensors Subcommittee of the
768 National Institute of Standards and Technology in the U.S. Department of Commerce, although the
769 documents issued by SWGDOG remain under that organization’s imprint at present.) While such
770 guidelines have been referred to by handlers in courtroom testimony (*U.S. v. Audelo-Marquez*), those
771 guidelines have not been followed by working handlers who have testified in criminal trials. There may
772 be facilities within certain law enforcement organizations, such as the U.S. Federal Bureau of
773 Investigation (FBI), an agency perhaps closer to the centralized police authorities conducting scent
774 lineups in Europe, that could conduct scent lineups in a more sophisticated fashion than has been
775 demonstrated in U.S. case law, but evidence of such procedures is seldom available from U.S. case law.
776 In *Iowa v. Frederiksen* 2016, FBI agents used bloodhounds to match scents to attempt to determine
777 whether a suspects’ scents could be found at locations associated with a crime. The scents of the suspects
778 were created using “a low airflow vacuum” and a “canine manager keeps the dog handlers ‘blind to the
779 case’ to eliminate potential claims of bias. The case is notable for establishing that the FBI, as many other
780 agencies in the U.S., uses bloodhounds and scent transfer units (or something close to it) in scent work,
781 and that blindness of handlers is preferred, but it explains little about the agency’s overall use of scent
782 identification dogs. One FBI official has testified on behalf of individual handlers even though the
783 techniques of those handlers would likely not satisfy SWGDOG guidelines (*California v. Alonzo* 2008).
784 Thus, SWGDOG and other guidelines remain theoretical and outside of the cases that have produced U.S.
785 judicial decisions and orders, and only the latter constitute the positive law of the U.S. on scent lineups.
786
787 The authors believe it is premature to suggest a list of best practices. Nevertheless, it is possible to
788 describe certain areas where police practices are similar, and certain areas of research consensus that may
789 indicate some starting points for an international effort and discussion towards best practices. There are
790 least two general approaches to materials that hold scent, i.e., (1) cotton (sometimes blended) and similar
791 materials and (2) steel tubes. There seems some value in continuing research with both types of scent

792 materials. Scent samples in the lineup should only be used once for a dog since they may leave cues when
793 they indicate. Objects holding scent in the lineup should be cleaned or replaced, and the position of target
794 samples randomized, during official trials.

795
796 There is variation in both police practice and research traditions about the number of decoy scents in a
797 lineup, but it might be possible to set a minimum number at 4. Decoy scents are usually collected from
798 individuals of the same race, gender, and age as the suspect, but additional similarities may be
799 appropriate. Decoys should ideally not be police officers, but in any case should not be known to the dogs
800 and should have no connection with the investigation or the investigating unit of a case. Scents presented
801 together in a lineup should be collected as closely together in time as possible.

802
803 There should likely be disqualifying control trials, as well as zero trials, before an official trial, though
804 this may also be an appropriate area for further research. There appears to be a consensus from both
805 police and research practice as to how much a dog should work during a day or week. There is variation
806 in the number of stations in both research and police practice and the area needs further research analysis.
807 There should be a minimum number of trials before an identification can be introduced in a criminal trial.
808 Many countries require more than one dog be used for an official identification, which again should
809 receive further research attention.

810
811 Alerts should be visible to more than just the handler, so the handler should be able to describe a unique
812 alert for a dog to an observer. To prevent any bias, the person calling the alert should not be aware of the
813 position of the odor of the suspect in the lineup. There is no consensus as to whether all stations should be
814 sniffed after a correct alert. This should receive additional attention as the absence of such a requirement
815 affects the calculation of the statistical probability of a correct hit by chance. Official trials should be
816 videotaped.

817

818 The authors believe that trials, except for the early stages of training, should be double-blind, i.e., blind as
819 to the handler as well as anyone whose presence may be perceived or sensed by the dog. Thus, an
820 experimenter who can call a correct alert in control trials should be separated from the lineup area in order
821 not to affect the handler's behavior, which might be a cue to the dog. The use of rewards is highly
822 variable and should be the subject of further research. When rewards are appropriately given, there is a
823 consensus that they should be given immediately after a correct indication through a conditioned
824 behavioral response.

825

826 The authors believe that the probability of correct indication by chance should always be calculated in
827 official trials, though we acknowledge that there is not a consensus in actual practice here. There should
828 be a greater connection between research groups around the world and between these groups and police
829 authorities that are implementing scent lineups. There has arisen both public and judicial suspicion
830 regarding lineups in many countries. This concern must be addressed if the technique is to continue in
831 forensic practice and judicial acceptance.

832

833 The authors acknowledge that the scent lineup may eventually be superseded by other forensic
834 approaches and specifically by the possibility that individual odors of humans may in time be identified
835 by techniques using gas chromatography/mass spectrometry. Cuzuel et al. (2017) noted that forensic
836 profiling of human odor could be useful in supporting information provided by dogs for courts, but in
837 time it may be that such chemical techniques would relegate scent identifications to a secondary function
838 in identifying perpetrators by their odors.

839

840 **CONCLUSION**

841 The scent lineup, as a forensic procedure, is in serious trouble in some countries, and is
842 experiencing a decline of usage in others. It has to be taken for granted that the scent lineup

843 identification will not show 100% accuracy all the time. However, experimental studies where
844 statistical significance was estimated show that the identification accuracy of the scent lineup
845 significantly surpasses results produced merely by chance. This argues that scent lineup
846 identification of perpetrators can at least produce corroborative evidence so that neither courts
847 nor police should totally reject use of the procedure. On the other hand it has been widely
848 accepted that a scent-lineup identification must not be taken as the sole or principal evidence
849 leading to prosecution and sentencing. In view of some controversies and doubt related to the
850 fact that no absolute accuracy of the lineup identification could be proven, there was and will be
851 a tendency to dismiss this method totally from forensic practice. Nevertheless, the authors
852 believe that this technique, conducted with procedures, developed over the nearly thirty years in
853 which it has been subjected to scientific investigation, can provide valid forensic data for
854 criminal investigations and can be corroborative of other evidence in prosecutions. The authors
855 also believe that specific country experiences and resources can lead to acceptable variations in
856 procedures. In order to have a future as a forensic technique capable of producing such data and
857 evidence, the authors also agree that greater international communication and collaboration
858 should continue to produce research regarding this technique, and that disseminating the results
859 of such research will increase the probability of judicial acceptance in all countries where
860 sophisticated programs can be developed.

861

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865

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867 **provided data for The Netherlands, obtained the assistance of contributors for Belgium and**
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869 **Z.B., D.C., M.G., I.H., P.K., F.L., E.R., K.S, and L.W., provided information on specific countries**
870 **and are listed alphabetically by last name, their affiliations indicating the countries for which they**
871 **were responsible.**

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Table 1. Collecting and handling of scent samples

Country	1.1. Materials that may hold scents of suspect and decoys	1.2 Storage of crime scene scent samples	1.3. Time restrictions as to how long after crime scent lineup may be conducted	1.4. Time restrictions as to taking of scents of suspect and decoys and use in lineup	1.5. Are stations in the lineup cleaned or replaced between trials or for consecutive dogs?
Belgium	Stainless steel tubes	Material evidence collected at crime scent stored in plastic bag	Up till 30 days	Not prescribed, but generally 1 to 2 days	Steel tubes are used only once in 1 lineup with 1 dog
Czech Republic	Aratex (76% cotton, 21% rayon, 3% polyamide), but another product is being tested	Material evidence collected at crime scent stored in glass jar	Between 2 days and 8 months	Between 2 days and 8 months	Jars may be replaced between dogs; this is up to the handler during training
Finland	Stainless steel tubes; we were on the way to start to use Kings Cotton	Material evidence collected at crime scent stored in special plastic bag for arson samples, or glass jars, or scent sample taken with Kings Cotton gauze stored in glass jar, all at room temperature and preferably dark	No formal limitations, usually within 1-2 year	Not prescribed, but generally 1 to 2 days	Steel tubes are used only once in 1 lineup with 1 dog; we changed to have tubes in glass jars on platform; jars used only once
France	Kapp Péterné® (Hungary) cotton squares (for body and trace scents)	Material evidence collected at crime scent stored in glass jar	No specified limits but trace scents often collected within 24 hours of lineups; most	No specified limits but trace scents often collected within 24 hours of lineups; most	Jars are changed randomly between successive trials in training, and scents are replaced between

			common storage time between 1 day and 3 months	common storage time between 1 day and 3 months	dogs; in official trials, jars are rearranged between runs of the same dog; cotton squares in jars are replaced between trials using different dogs
Germany Nordrhein-Westfalen Former German Democratic Republic	Stainless steel tubes Cloth stored in jars.			Not specified, preferably as soon as possible 24 hours after the scent is taken	Replaced between trials For consecutive dogs replaced scent article Replaced between trials; if the dog matches the target scent five times surely, the target scent is exchanged
Hungary	Special 15x20 cm, constant-composition textile made for only this purpose. It has to be made of woolly and loose material	Material evidence collected at crime scent stored in glass jar	24 hours between collection of scent and use for an ID; after 3 years scent samples are destroyed	24 hours between collection of scent and use for an ID; after 3 years scent samples are destroyed	A dog performs 5 trial; the glasses used for the lineup are not exchanged or cleaned, only their position is changed
Lithuania	Bleached flannel cut to 30/40 cm strips	Material evidence collected at crime scent stored in glass jar	Scents can be used 24 hours after the collection, but not before; body scents can be stored for 1 year only	Scents can be used 24 hours after the collection, but not before; trace scents can be kept in the storage room for 5 years whereas body scents can be stored for 1 year only	Stations are cleaned between each trial and jars containing scents are replaced; collected scented material is discarded and the jars cleaned before sterilization
Netherlands	Stainless steel tubes	Material evidence collected at crime scent stored in plastic bag, or scent sample taken with Kings Cotton gauze stored in glass jar, all at room temperature and preferably dark	No formal limitations, usually within 1 year	Not prescribed, but generally 1 to 2 days	Steel tubes are used only once in 1 lineup with 1 dog
Poland	Adsorbant swabs consisting of sterile cotton sewed in sterile gauze in closed			Minimum 24 hours unless immediate ID is necessary	A separate set of jars is used for each dog; if a dog has marked a jar during a run, that

	bags manufactured by TZMO S.A. Poland				jar is replaced before the next run of the same dog
Russia	Cotton fleecy fabric (5 x 3 cm)	Sheets of cotton fleecy fabric with scents of suspect and decoys stored in glass jars with tight metal lids in refrigerator	No specified limits. Lineup procedures are usually conducted within 24 – 72 hours after sample collection, but time interval between sample collection and lineup can be increased to several weeks or months	Samples are frozen immediately in chemically clean dry ice, and can be stored up to 5 years in carbon dioxide	Each dog sniffs clean jars with the order of presentation changed.
U.S.	Scent lineups have often used objects collected at the crime scene, but also footprints, sometimes transferred to scent pads by scent transfer units (STU 100)	No specified requirements or materials but samples often collected on gauze pads with scent transfer units (STU 100) (<i>California v. Alonzo</i> 2008)	No specified requirements but courts have considered storage and contamination issues, such as where all decoy scents were stored in same duffel bag in Ziploc bags (<i>Buchanek v. City of Victoria</i> 2009); FBI uses glass containers (testimony of Dr. Kenneth Furton in <i>Texas v. Dominguez</i>)	Not prescribed judicially and seldom mentioned, but cases state testing may follow sampling in hours up to 3 years in one procedure	There is no such requirement and some cases indicate stations were not changed or moved between successive runs or different dogs

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Table 2. Characteristics of decoys

Country	2.1. Requirements on use of decoy scents in lineup	2.2. Whether decoy scents must be taken from individuals similar to the suspect in sex, age, occupation, or other specified criteria	2.3. Can decoys be police officers?	2.4. Is there a requirement that all scents, including decoys, be novel (unfamiliar) to dogs during training or testing (certification) stages, or in actual judicial trials?
Belgium	Scents from 6 decoys are collected for lineup of 7 scents, 1 being a suspect); there are 2 such lineups	No identity requirement but scents must be collected at same place and time as suspect's scent is collected	Yes	Generally no requirements, some scents may be sporadically re-used Training: novel Certification: novel Judicial trials: novel
Czech Republic	Practice is to use 6 decoy scents and 1 suspect (target) scent per lineup	4,000 body scents are stored for maximum 2 years, selected for specific lineups based on the profile of the suspect; decoy scents are destroyed once used	No	Training: novel Certification: novel Judicial trials: 1 st dog novel 2 nd dog scents that were used for the 1 st dog

Finland	Scents from 6 decoys are collected for lineup of 7 scents, 1 being a suspect); there are 2 such lineups	No identity requirement but scents must be collected at same place and time as suspect's scent is collected. If suspect was female there should also be female decoy	Yes, some of them, but not from officers involved or in any way connected with investigation	Generally no requirements, some scents may be sporadically re-used Training: novel Certification: novel Judicial trials: novel
France	Practice is to use 4 decoys in lineup of 5 stations; scents can be trace scents or body scents	Decoy (distracting) scents are collected from unrelated persons identical to the sex, age, and ethnicity of a suspect	Rarely, but only in training phases	Training: novel Certification: novel Judicial trials: novel
Germany Nordrhein- Westfalen	1 target scent, 6 decoys taken in a similar way on stainless steel tubes	Similar to the suspect as to the sex and age, but this is not specified in the method.	In practice yes, but not specified in the method	Training: unknown Certification: unknown Judicial trials: unknown
Former German Democratic Republic	1 target scent, 6-8 decoy scents	Similar to the suspect as to sex, age and profession (for example butcher), but this is not specified in the method	In practice sometimes, but not specified in the method	Training: novel / re-used Certification: unknown Judicial trials: unknown
Hungary	Time between collecting scent from decoys and the suspect has to be as short as possible; collecting scent from person being under the effect of strong medicine or drugs and from menstruating women is not allowed	Only the sex of the decoy and the suspect have to be identical	Yes, but not from an officer who was at the crime scene; no official rules	Training: novel / re-used Certification: novel / re-used Judicial trials: novel / re-used
Lithuania	9 distractors are placed on the circle and 1 target	Decoys are chosen in order to be as similar as possible to the target and the main factors are sex and age	Sometimes, if the officers have never had contact with the dogs before	Training: novel Certification: novel Judicial trials: novel
Netherlands	Scents from 6 decoys are collected for lineup of 7 scents, 1 being a suspect); there are 2 such lineups	No identity requirement but scents must be collected at same place and time as suspect's scent is collected	Yes	Generally no requirements, some scents may be sporadically re-used Training: novel Certification: novel Judicial trials: novel
Poland	Scents of 10 to 20 decoys are collected; separate scents are collected for each dog used	Decoy scent samples are collected from same sex and ethnic group as suspect, within 5 years of same age, in a similar occupation, with similar diseases and medicines (if relevant)	Yes, but not from officers involved or in any way connected with investigation	Training: novel Certification: novel Judicial trials: novel
Russia	13 jars are prepared for each trial; 10 for decoys; more than 1 suspect's scent can be used; 1 of the last 3 jars the dog sniffs contains a	Some decoys should be of same sex, age, and profession as suspect, though not all decoys must be so; forensic investigators assure sampling	Yes, if unfamiliar to dogs used in lineups	Training: novel / re-used Certification: novel Judicial trials: novel

	marker sample, the scent the dog is provided before traversing the lineup	of decoys and suspect are close in time		
U.S.	No standard practice though of 59 cases mentioning decoys, 22 were used in lineups of persons, 11 in lineups with crime scene objects, and 26 in lineups using scent pads	No judicial requirement; 13 cases mention that the handler used decoys of the same race or ethnicity, and 14 mention decoys of same gender; most cases give no indication	Decoys were specified as officers in 10 cases, including police officers in uniform in lineups of persons; many other procedures probably used scents of police officers as decoys	Training: No requirement, and decoys frequently re-used Certification (generally tracking dog certifications): sometimes re-used Judicial trials: No requirement, decoys frequently re-used

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Table 3. Control and disqualification trials

Country	3.1. Number of disqualifying control trials	3.2. Negative check (zero) trial requirement (as control or within identification trials)	3.3. Time intervals between trials
Belgium	Valid tracking certification and additional valid scent lineup module certification	No	3 – 4 lineups can be conducted per day, though there is no required limit
Czech Republic	2 lineups (minimum) using crime scene and suspect scents, but additional control trials possible	Prior to 1 April 2018, such trials were required after one or two lineups performed correctly; zero trials not required after that date	Quickly, perhaps 1 – 2 minutes; dogs can work 5 – 6 runs per day, but sometimes 15 – 16
Finland	Valid certification required, and correct execution of 2 control trials	No requirement during official lineups but used during certification test	Runs follow closely and 4 runs can take 2 – 4 minutes; between run 2 and 3 team should have a short break in next room, 3-5 min depending on handler. 3 – 4 lineups can be conducted per day, though there is no required limit
France	3 lineups with procedure similar to training, 15 minutes before official ID tests	Zero trials used during training stages, disqualifying trials, and official ID lineups	Minutes, no more than 6 – 8 trials per day
Germany Nordrhein-Westfalen	One control trial per dog to exclude scent attractiveness	Not specified	Usually consecutively on the same day, no precise time interval given.
Former German Democratic Republic	Not specified	Not specified	Not specified but usually consecutively on the same day, no precise time interval given; depends on the dog; performance was assessed by handler.
Hungary	Different (1-3) depending on the department.	No requirement	It depends on the dog. Generally, there is no time intervals between trials but

Lithuania	Prior to each official test, all dogs must complete two trials correctly	Negative check trials are inserted during training; one negative check every three trials	if the dog needs rest, break is allowed During the training period, dogs run the circle several times per day; there are 15 minute intervals between successive trials, once a dog is certified, it is trained once a day, between 2 to 5 times a week
Netherlands	Valid certification required, and correct execution of 2 control trials	No requirement during official lineups but used during certification test	Runs follow closely and 4 runs can take 2 minutes; 3 – 4 lineups can be conducted per day, though there is no required limit
Poland	3 lineups (minimum), 2 with sample randomly placed in lineup, and 1 zero trial with no matching sample	Not conducted during official trial sequences; one zero trial out of 3 control trials sequence	Lineups are separated only by time needed to change samples or positions; dog can perform only 1 set of tests per day
Russia	All dogs used must be tested against decoys, with showing of interest leading to disqualification	No requirement	4 – 5 trials per dog per day, but can be less of dog appears not to be motivated
U.S.	No statutory or judicial control-trial requirement, though some handlers run proofing trials	No requirement, though sometimes used by specific handlers	Generally runs follow closely on one another, though one case indicated a 10-minute gap between a proofing procedure and a lineup

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Table 4. Experimental setup of the lineup identification

Country	4.1. Number of stations in a trial	4.2. Number of trials before an identification can be used as evidence in a criminal prosecution	4.3. Number of dogs used in an official identification
Belgium	7	No evidence in criminal prosecution – only an indication	1
Czech Republic	3 - 7	3 (by same dog)	Depends on number of trace scents collected at the crime scene; if only 1 scent, then only 1 dog
Finland	7	2 control runs on 7 scents (6 decoys + 1 suspect), followed by 2 runs using crime scene scent without control person A (5 decoys + 1 suspect) = 4 runs	1 dog per lineup, no more than 1 lineup is necessary
France	5 typically	2 matching combinations (trace scent to body scent and v.v.) are used with negative check trials between tests ; then other dogs perform similar sequences	Minimum 2, but 7 were used in a case with a high level of crime scene scents
Germany Nordrhein-Westfalem	7 in lineup	6 trials (including pre-testing); Matching of suspect to crime scent is recognized if 3 dogs independently of each other match the tube touched by the suspect.	3

Former German Democratic Republic	6-8 in lineup		Not specified, but in practice at least 2
Hungary	5 glass pots in a lineup	5 trials	Minimum 2 dogs
Lithuania	10 in circle	2 – 3 trials and the results must be confirmed at least by another dog (so 2 dogs minimum for a judicial ID)	At least 2
Netherlands	7	2 control runs on 7 scents (6 decoys + 1 suspect), followed by 2 runs using crime scene scent = 4 runs	1 dog per lineup, no more than 1 lineup is necessary
Poland	5 minimum but generally 6 for line; 10 minimum for circle	3 – 5 control trials, followed by official trials (runs), which can vary depending on number of dogs used, but 3 minimum trials for ID to be declared; outcome of each dog must be consistent if 2 dogs used	2 dogs for an official lineup
Russia	12 in circle; lines not used	3 runs per dog with alert to suspect's scent by all 3 dogs is considered sufficient for proof of ID; if 1 of first 3 dogs does not alert to suspect's scent, dog 4 provides sufficient proof with an alert to the suspect's scent on 3 runs	3 dogs minimum (or 4 if 1 of first 3 does not alert correctly)
U.S.	Highly variable; often not specified, but in 1 case there were only 2 stations, 1 case had 3, 7 cases had 4, 12 cases had 5, 15 cases had 6, and 1 case had 7	Most judicial cases found a single run with an alert sufficient for admission of evidence; 60% of cases involved 1 dog, 20% involved 2 dogs, and 30% involved 3 dogs	No specified number, and dogs could perform more than 1 function (in 20 cases, dogs were used for more than one function, usually tracking in the initial part of the investigation, then for a scent lineup once a suspect was apprehended)

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Table 5. Alerting of dogs

Country	5.1. Who calls alert?	5.2. Requirement that all stations be sniffed (even after correct alert)	5.3. Is video-recording of official trials required or standard?
Belgium Czech Republic	handler Handler in prior procedure, but now the expert in the experiment	no Yes; target scent sometimes placed at end of line so dog must sample all stations to correctly alert	No – handler makes written rapport Only when ordered by judicial authority
Finland	Handler calls, and gets a light signal when dog is correct; we started to change it. Handler was sitting with his back to line ups, no eye contact; supervisor would call the alert	No	No; all lineups was video-recorded for supervisor use
France Germany Nordrhein-Westfalem	Technician Assistant	No, sufficient to sniff stations until dog alerts No, but this is not specified in the method.	With positive ID, lineup is repeated and videotaped Yes

Former German Democratic Republic	Handler (dog's behavior is "down")	Once alerted, the position of target scent must be swapped.	No
Hungary	Handler (generally, though sometimes there is a separate experimenter)	Not an obligation	Only on request
Netherlands	Handler calls, and gets a light signal when dog is correct	No	Not usually
Lithuania	The judicial expert who placed the target in the circle	When the target is placed far away from the beginning of the circle it is not absolutely required. However, there is no strict requirement. Sometimes the dog handler asks for his dog to sniff all stations, sometimes not. In general, all stations are checked	No
Poland	Alerts are expected to be clear to anyone; experimenter indicates by a light signal if alert was correct	No (though required during training)	Required if crime could result in sentence greater than 3 years imprisonment, or upon order of court or prosecutor; generally conducted anyway
Russia	Experimenter	Yes (because marker in last 3 stations)	Yes, uniformly
U.S.	Handler	No judicial requirement, but procedures of some handlers require all stations be sniffed	No judicial requirement but occasionally done

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Table 6. Degree of blindness

Country	6.1. Degree of blindness required as to the placement of the target scent	6.2. Must an experimenter who is aware of the position of the target sample be totally isolated from any contact with the handler and dog?	6.3. Means by which observers and handlers communicate, including visual or acoustic signals, a clicker, etc.
Belgium	Single-blind (technician present is aware)	no	Verbal notification by technician
Czech Republic	None	Not relevant because handler is not blind	Not applicable (no observers)
Finland	Double-blind	Yes	Visual (light)
France	Single-blind (technician present is aware, though required to look in opposite direction to handler)	No (but technician is alien to the dog)	Verbal notification of handler by technician
Germany Nordrhein-Westfalem	Single-blind (handler must be blind)	No, but this is not specified in the method	Green or red light, but not specified in the decree. Not specified

Former German Democratic Republic	Depended on individual case, sometimes double-blind, sometimes single-blind, sometimes the handler knew position, especially if scent sample was taken by handler.	No, but this is not specified in the method	
Hungary	Suspect/lawyers may observe the tests being visually isolated from the dog, the dog handler and the experimenter by a one-way mirror. The experimenter and the dog handler know the position of the target scent in the lineup, however, do not follow the dog and do not give any signals to the dog	No	The experimenter and the dog handler are allowed to communicate directly (verbally). No communication is allowed between observers and the dog handler or the experimenter
Lithuania	Single-blind (handler never knows where the target is placed in the circle)	No (technician is present in the room)	Visual and clicker
Netherlands Poland	Double-blind Double-blind (expert observes through one-way mirror)	Yes Yes	Visual (light) Visual (lamp), to tell handler to bring dog into or exit from sniffing room, another lamp signals that indication was correct or incorrect (or that experimenter deems dog refusing to work)
Russia	Double-blind	Yes (observes through video monitor)	Acoustic (clicker)
U.S.	Handler was stated to be blind in 13 cases and not to be blind in 4; double-blindness seldom mentioned	Generally no such separation of function in judicial cases though double-blindness as to observers mentioned in 1 case	Judicially described procedures with handler blindness sometimes indicate a second officer verbally notified the handler when the dog alerted correctly

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Table 7. Handling of dogs during trials

Country	7.1. Rewards that may be used for the dog, in control trials including treats, toys, etc.	7.2. Timing of rewards

Belgium	Retrieving tube after hearing choice is correct	Immediately after correct indication (self-rewarding of dogs by retrieving a target tube released from the electromagnet in the lineup)
Czech Republic	Petting, 1 treat for reward	After a hit or correct response
Finland	Retrieving tube when green light appears for handler; we changed it to give food and after that toy first click or verbal, depending on handler	Immediately after correct indication (self-rewarding of dogs by retrieving a target tube released from the electromagnet in the lineup); we changed this so that after correct alert/indication dog remained at the right position pointing or standing or laying down, handler went to dog and gave reward he wanted to use to dog (food, ball/toy, tube); we also changed to tubes in glass jars on the line-up.
France	10 g Knacki® sausage upon correct response; ball at end of trial, but varied depending on the preferences of dogs	After a correct alert and technician signals handler; or at the end of a negative check (zero) trial, when the dog returns to the handler
Germany Nordrhein- Westfalem	Depends on individual dog, mostly toys	Immediately after correct indication
Former German Democratic Republic	Not specified, but in practice treats after each correct indication	Not specified, but in practice immediately after each correct indication
Hungary	Different rewards, praise, petting, food, toy	After indicating of the target scent or after refraining from a false alert and returning to the handler
Lithuania	A treat or a toy, depending on dog's preference	Reward is given when a dog indicates the correct station
Netherlands	Retrieving tube when green light appears for handler	Immediately after correct indication (self-rewarding of dogs by retrieving a target tube released from the electromagnet in the lineup)
Poland	Food treats, toys after completion of a test	Rewards can be given after a run, after a correct response, or after returning to handler; after completing an entire test, dogs are given a toy to retrieve
Russia	Food after experiment gives acoustic click signal	Seconds after acoustic signal given
U.S.	Nothing judicially specified, but handlers regularly use treats, praise and petting	Generally not indicated but assumed to be after a trial is completed

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Table 8. Dog characteristics and training

Country	8.1. Breed preferences for scent lineups	8.2. Age requirements for dogs performing scent lineups	8.3. Period of training before dogs can make an official identification or certification requirement
Belgium	Mainly German Shepherd	No requirement but dogs begin training at about 1 year old	Generally about 1 year for tracking, training on scent lineups is optional and begins after dogs are certified for tracking
Czech Republic	German shepherd	Qualified at 2 years	1 year after dog is 1 year old preceded by 10 weeks of basic training
Finland	Commonly crossbreeds of Malinois, German shepherd, and Dutch shepherd	No requirement but dogs begin training at about 1 year old and train for a little less than 1 year	Generally about 1 year

France	German shepherd Belgian Shepherd	Dogs enter program at 2.5 years, oldest working dog is 9 years	Dogs must give no false alerts over 200 trials, followed by 1.5 – 2 years training
Germany Nordrhein-Westfalem	German shepherd or Belgian shepherd, but not specified in the method.	Not specified	Not specified, depends on the individual dog’s training performance
Former German Democratic Republic	German shepherd	Age over 1.5 years (according to DERDA, 1983)	4 phases (240 hours) of an intensive training (according to DERDA, 1983)
Hungary	German and Belgian shepherds or their mix.	No requirement but a dog must be able to fulfill its tasks, though generally from 1.5 to 9 or 10 years.	6 months
Lithuania	German shepherd	From 2 – 3 years old when they begin to about 10 years old	Training lasts approximately 1170 hours.
Netherlands	Commonly crossbreeds of Malinois, German shepherd, and Dutch shepherd	No requirement but dogs begin training at about 1 year old and train for a little less than 1 year	Generally about 1 year
Poland	German shepherd and Labrador retriever, but also Rottweilers and others, sometimes reflecting handler preferences	Dogs qualified at 1 – 2 years, and sometimes retired at 10 years	6 months at Kynology Department of Police Training Centre, but up to 12 months of handler training with handle
Russia	Jackal-dog hybrids	1.5 – 10 years	Basic training c. 3 months, match-to-sample training c. 2 months, learning scent lineups c. 1 month
U.S.	Bloodhounds used in more than half of published cases, though German shepherds and Labrador retrievers occasionally used	No age requirements have been specified by courts; age of dogs were occasionally given, ranging from 2 years old to 11, with an average age of 6 years	No requirement, but individual handlers select dogs for training at about 1 year; period of training highly variable; training as a tracking dog was sufficient for a dog to participate in a scent lineup in a number of judicial decisions

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Table 9. Osmology expert and handler qualifications

Country	9.1. Qualification requirements for handlers	9.2. Can handlers have more than one dog?	9.3. Frequency and length of training sessions after teams begin performing scent lineups
Belgium	Handler tested with dogs on proficiency but also pass a theoretical test	Usually only 1 dog	Usually 50 hours/month but this includes training on tracking
Czech Republic	Handlers obtain a certification with their dogs, which involved annual retesting, though this has ceased	2 is common, 3 is exceptional	6 or more training trials per day is common but up to handler
Finland	Handlers tested as team members with their dogs on proficiency,	Handlers may have 2 dogs, but dogs have	Not specified, usually 2 – 3 scent IDs per day, 2 + 2 days per week; dogs

	but also must pass a test on legal, forensic, and scientific scent matters; handlers should be police officers	only 1 handler; dogs were living at handlers home; if handler was a long time out of work (pregnancy + maternity leave or sick leave) another handler could handle that dog Handlers may have 2 dogs, but dogs have only 1 handler	were also trained for id-tracking and id-scent search (articles and locations) 6 – 8 training trials per day, 5 days per week
France	Police officers undergo dog handling training sessions of 3 months, followed by a final exam that allows them to join the canine center in Ecully		
Germany Nordrhein-Westfalem	Not specified, only dogs and handlers from the Nordrhein-Westfalen State police school for police dog handlers	Yes, in practice 2 dogs.	Not specified, depends on the individual dog's training performance; annual certification required
Former German Democratic Republic	Dogs had to be trained at the special school of the Ministry of the Interior for service dogs in Pretzsch (<i>Spezialschule des Diensthundewesen</i>)	Not specified, but in practice two dogs	Not specified
Hungary	The dog handlers and their dogs have to complete a special course	Yes	Minimum 2 hours 3 times a week
Lithuania	Dog handler must pass a certification exam every 18 months	Handlers may have 1 or 2 dogs	1 hour, 2-5 times a week
Netherlands	Handlers tested as team members with their dogs on proficiency, but also must pass a test on legal, forensic, and scientific scent matters	Handlers may have 2 dogs, but dogs have only 1 handler	Usually 2 – 3 scent IDs per day, 4 days per week
Poland	Obligatory training for osmological ID is conducted by the Police Kynology Department of the Police Training Centre, which includes an exam involving theoretical aspects; during training, each participant trains 2 dogs; other requirements for other aspects of osmology work	A handler trains 2 dogs, but maximum is 3	1 training session of 6- 20 trials per day, 5 days per week
Russia	No specific certification but handlers must undergo an educational program in osmology	Program has all handlers working with all dogs	Daily training if possible with 1 – 3 trials
U.S.	None judicially required and many are self-taught; some have military training in working with dogs	No limit, though many have 3 or even more	No specified requirement, highly variable in cases, but some U.S.-based police dog organizations recommend 4 hours per week

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1111 Table 10. Measures undertaken to decrease judicial skepticism or public mistrust as to the

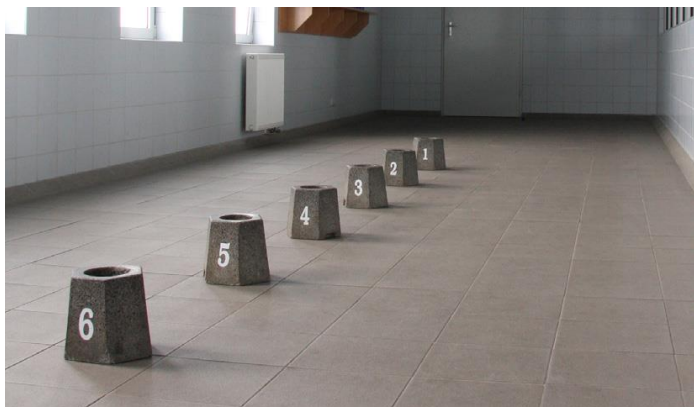
1112 reliability and validity of scent lineups in criminal prosecutions

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Country	10.1. Must the probability of a correct indication by chance be estimated, or such an estimate standard?	10.2. Have experimental studies been undertaken by independent scientific institutions to assess validity and reliability of scent lineup identifications?	10.3. Are scent lineup identifications currently performed by police as evidence for courts (or specify periods when such were performed)?
Belgium	Because of fixed practice, probability is known	No	Not as evidence but in early investigation lineup results steer the investigation
Czech Republic	No	Yes	Yes
Finland	Yes	Yes	Yes
France	No	Yes	Yes
Germany Nordrhein- Westfalen	The probability of correct indication by chance, using three trained dogs has been calculated as 1 : 1.2 million	Yes, by Prof. Dr. Hans Hilden, Universität - Gesamthochschule Paderborn.	Currently no 1988-2011 Nordrhein-Westfalen 1989-2012 Baden-Württemberg
Former German Democratic Republic	No, but not specified	Not specified	
Hungary	No	Yes, but the police were not involved and were not advised of the results	Yes
Lithuania	No, assuming that the probability of a single correct hit by chance is 1/10, and scents are replaced after each trial, of each dog and hits must be confirmed 2 to 3 times by the same dog and by at least another dog, the total probability is deemed very low.	No	Yes
Netherlands	Yes	Yes	No
Poland	No, though under previous procedures this was calculated and published	Yes	1962 - currently
Russia	Because of fixed standard practice, such probability is known	Yes	Yes
U.S.	No, though one 2011 Texas case criticized a handler for not calculating a rate of error	Not as to procedures used by police and contract handlers; research has been done by U.S. researchers on identification issues	No reported uses for 8 years but some states have not judicially precluded uses of scent lineups

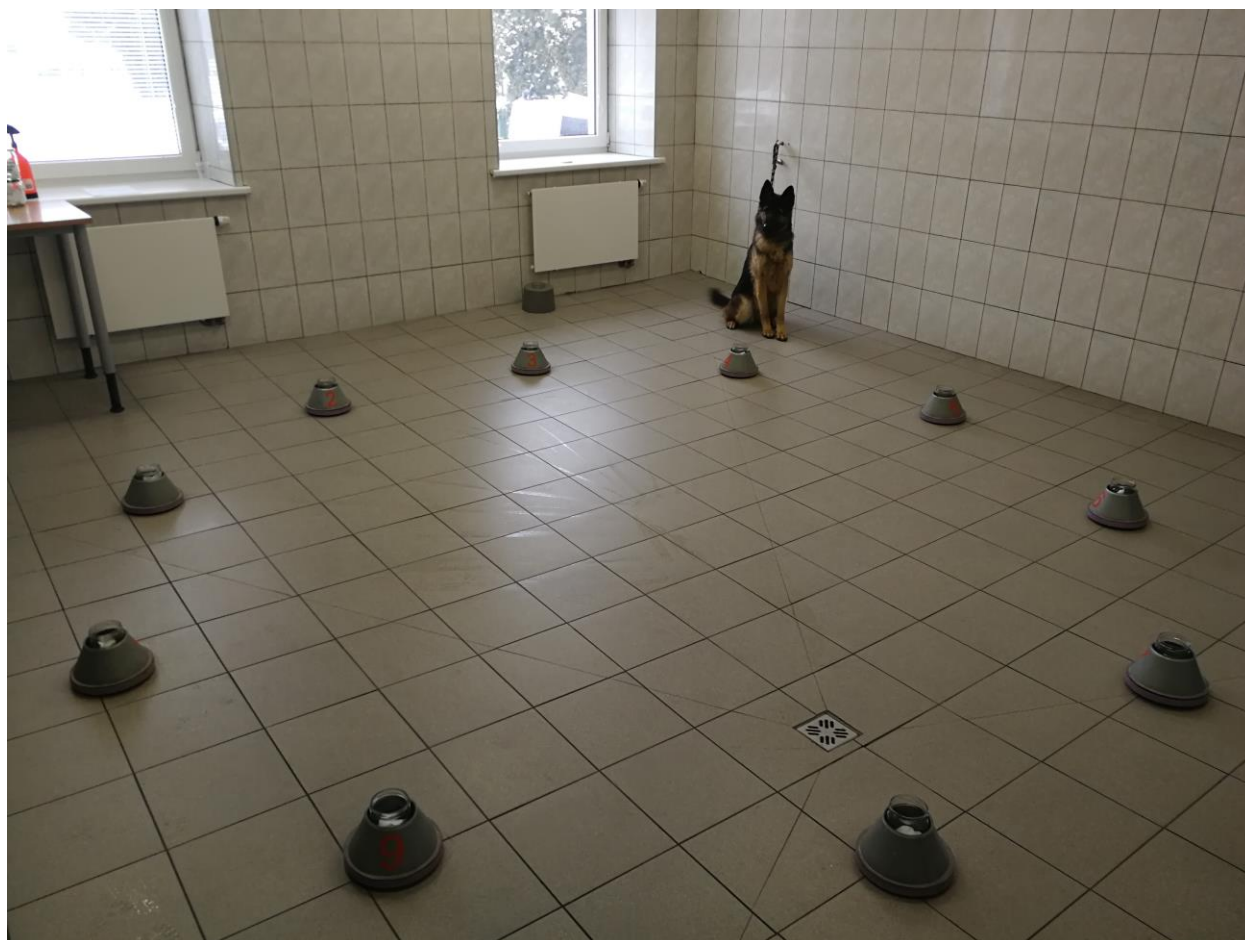
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1117 An example of the lineup (Poland)

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1120 An example of the lineup (Lithuania)

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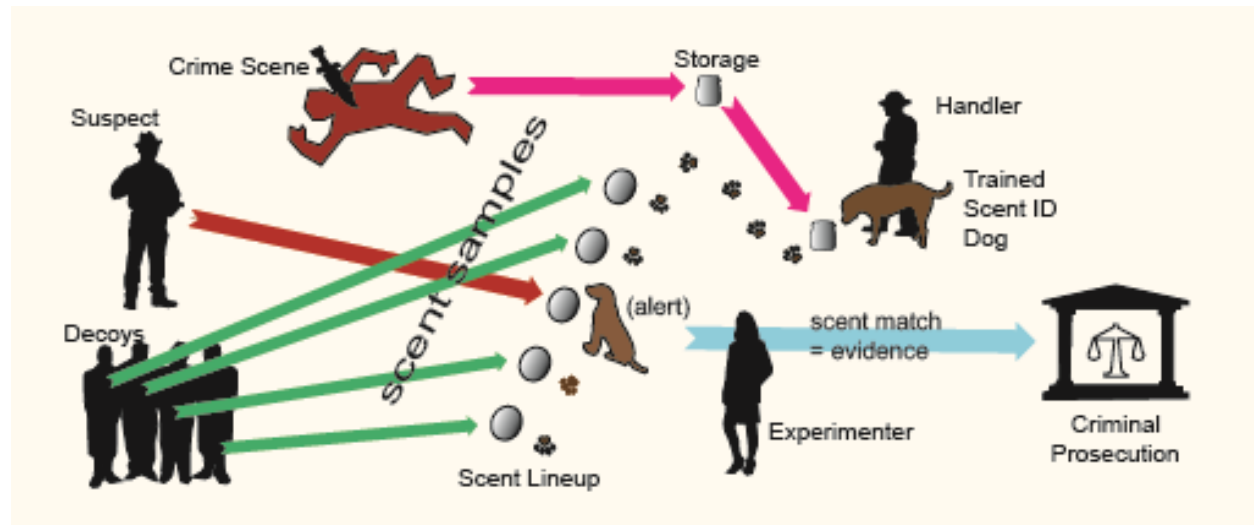
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1126 Graphical abstract



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