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Information-seeking behaviour of sniffer dogs during match-to-sample training in the scent lineup

Qualitative and quantitative changes in dogs' information-seeking behaviours during the subsequent phases of operant conditioning training using a scent lineup, were investigated. Particular interest was paid to behaviours which may have an impact on errors committed by dogs at work in a scent lineup and thus on the reliability of the canine identification of humans on the base of scent. Significant individual differences were found in dogs' performance in operant conditioning during match-to-sample trials. The style and time of sniffing the pattern scent sample as well as the searching time and number of stations sniffed in the lineup were found to influence the percentage of errors (false positive and false negative indications) made by dogs. The effects of the dogs' routine e.g. omitting stations, using other cues than olfactory ones (visual) and effects of the non-verbal communications between handler and dog have been discussed.

Keywords: information-seeking behaviour; dogs, sniffing, training, scent lineup

Introduction

Excellent canine olfactory acuity and learning ability are the reasons why the police and law enforcement forces use the dogs for operational tasks. From the end of nineteenth century on, police dogs were mostly used for tracking perpetrators by sniffing their footprints on the ground and leading the police dog handler directly from the scene of crime, to the place where the perpetrator was hidden. During the subsequent decades other special fields of using sniffer dogs emerged and currently dogs are used not only for tracking but also for detection of drugs, explosives, smuggled goods etc. Increasing mobility of perpetrators by using cars and other vehicles, significantly reduced the classical tracking of perpetrators. A new role of sniffer dogs emerged in the field of forensic osmology which deals with the identification of perpetrators on the base of scent left at the scene of crime, by comparing the scent samples taken from suspects to that taken at the crime scene. In Poland this procedure was first introduced into police practice in eighties and was intensively developed in nineties of the twentieth century (Bednarek 1998; Gawkowski 2000). Although the scent identification by dogs is accepted

as evidence in jurisdiction in countries like USA, The Netherlands, Germany and Poland (Tomaszewski & Girdwoyn 2006), there is much controversy about the validity of this method. Schoon (1996) points out that there are no international standards for the way the dogs are trained, certified or used, nor for the experimental design at match-to-sample trials.

The lineups are used by the police in a number of countries to identify perpetrators on the basis of matching scents collected at the scene of crime to the scent samples taken from suspects (Brisbin & Austad 1991; Settle et al. 1994; Schoon & De Bruin 1994; Schoon 1996, 1997). Although the scheme for forensic scent trace examination is well established (e.g. Bednarek & Sutowski 1999), a number of questions arise as to the validity of this method. Very few peer-reviewed papers have been published and no appropriate statistical analysis of the data has been applied to demonstrate the validity of the canine identification of humans on the base of scent. We found no experimental work analyzing changes in dogs' performance during the training of naive dogs, until they reach a level that may be regarded as sufficient for operational use.

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The sense of smell plays the crucial role in many aspects of animals' life, especially in carnivores, being involved in information-seeking behaviour e.g. during searching for food or prey, in reproduction – e.g. for recognition of the phase of estrus cycle in females, for mutual recognition of the dam and pups, recognition of the members of own and alien species, for marking of the territory etc (Marchlewska-Koj, 1998; Dröscher, 1971). However, the canine sniffing and searching/indication in the scent lineup as used for forensic application is based on operant conditioning that is less relevant from biological point of view and the information seeking behaviour during this procedure is a learned rather than innate behaviour.

In order to make the forensic application of canine identification more plausible, a theoretical model of a human scent sample has been developed. According to this model a scent sample is composed of 4 putative components (Gawkowski et al. 1998):

- **individual human component** which is thought to be genetically determined, unchangable, unremovable and unique.
- **metabolic component**, related to the diet, metabolic disorders, diseases and medications ,
- **external component**, related to cosmetics and/or substances used for body care, personal hygiene, treatment of skin diseases etc,
- **background component**, related to odour typical for the place where the scent sample was taken and to the odour of materials and/or containers used for collection and storage of scent samples.

In the forensic identification of humans using a scent lineup, a specially trained dog is given a sample of human scent collected at the crime scene (so called “evidence scent”) to sniff at the starting position and next should sniff all stations (usually 5-7) containing different so called “complementary scents”, taken from the palm of people who were not involved into the crime and one scent sample (so called “comparison scent”) from individual who is suspected to leave his/her scent in the crime scene (i.e. to be there) when the crime was committed. The dog should match the scent of the suspect to that sniffed at the starting position. If the “comparison scent” of the suspect in the lineup is matching to the “evidence” sample, the dog has to indicate the scent of the suspect by performing a learned behaviour, usually lying down or sitting at the target station. If no sample in the lineup is matching to the “evidence scent”, the dog should refrain from the learned reaction (Bednarek & Sutowski 1999). The dog must distinguish the scent samples exclusively on the base of the individual component and should ignore all other components of the scent sample. During sniffing the “evidence scent” at the starting position, the dog must get enough olfactory information about scent molecules in order to distinguish that scent precisely from other scents.

Therefore the behavior and way of sniffing the sample at the starting position and during searching in the lineup may be regarded as an important information-seeking behaviour.

The aim of this work is to analyse qualitatively and quantitatively the changes in dogs' reactions during the subsequent stages of operant conditioning procedure using a scent lineup. Particular interest was paid to behaviours which may have an impact on errors committed by dogs at work in a scent lineup and thus on the reliability of canine identification of humans on the base of scent.

Material and methods

Six dogs (4 males and 2 females) of the German shepherd type were used for the training. The dogs were 8-12 months old and were naive at the beginning of the training. All dogs underwent a basic obedience training, prior to the training in the lineup. They were not selected on the base of their obedience or performance in the basic training. The dogs were maintained in individual kennels and fed with standard pet dog food with access to water ad lib. The daily feed ration comprised 1200 g moist food given after the training session at 2.00 p.m. and 250 g dry food in the evening. Independently of the individual training in the sniffing room, dogs were walked two times daily for approximately 30 minutes. They were enabled to move freely during walking. Four handlers trained and took care of the dogs for the whole period of the study. Each handler trained 1-2 dogs. In this paper individual dogs were denoted with three-letters initials.

The experimental procedure and keeping conditions for the dogs were approved by the 3rd Local Ethical Commission for Animal Experimentation in Warsaw, Poland.

Scent samples

The scent samples for the training were taken by holding a sterile cotton cloth (10 x 15 cm) in hand palms through 15 minutes. The donors of the scent samples were alien to the dogs. There was a different set of donors for each training day. No twins or closely related humans were used within the same set of donors. The samples were stored in sterile closed glass jars in room temperature for the period of 1-20 weeks before use.

Training procedure

Below, we give explanations of some terms used when describing the methods of the training and discussing the results:

Stations in the lineup = heavy pots with glass jars containing scent samples, situated in a lineup of 5 stations on the floor, 80 cm apart, forming an arch to be well visible for a stationary videorecording

Trial = walking of the dog along the scent lineup, sniffing

the samples and indication of the target sample by sitting or lying down

Pattern sample (“evidence scent”) = a human scent sample (or food scent sample in phase 1) given to the dog to sniff at the starting position before searching in the lineup. This sample is matching to the target sample (“comparison scent”), since both are taken from the same person)

Target sample (“comparison scent”) = a human scent sample (or food scent sample in phase 1) placed randomly in the lineup, to be indicated by the dog and matched to the pattern sample given to sniff (“taking air”) at the starting position

Blank sample = sterile cotton cloth used for collecting human scent, containing no human scent

Decoy (“complementary scent”) = a human scent sample taken on the similar cotton cloth as the target or blank sample, placed in the lineup but not matching to the sample given to sniff at the starting position. The dog should not indicate decoy sample

Active trial = a trial with a target sample in the lineup to be indicated by the dog

Zero trial = a trial without a target sample in the lineup i.e. only blank samples or decoys are placed in the lineup, and the dog should refrain from any indication

Indication = an operant conditioned reaction of the dog (sitting or lying down) in front of the target sample

False positive indication (false alarm) = an indication by the dog of a decoy or blank sample

False negative indication (miss) = lack of indication of the target sample in the lineup

The training to search the target scent sample in the lineup was conducted indoors in a room 7 x 7 m equipped with washable floor and heated in winter. During the training only two persons who were well known to the dog were present in the room:

- the experimenter who led the training procedure, put particular scent samples into 5 stations of the lineup, signaled the start of dog’s searching and gave an acoustic signal using a clicker, when the dog indicated correctly the target sample. The experimenter was invisible to the dog and to the handler and observed the dog’s work through video monitor.
- the dog handler who gave the pattern scent sample to the dog to sniff at the starting position, encouraged the dog to check and sniff the samples in the lineup and rewarded the dog with a piece of food after the clicker signal was activated, indicating a correct reaction of the dog.

Daily each dog made 8 -15 trials depending on dog’s motivation for work or getting bored, as judged subjectively by the handler. There were 3-4 training days per week. All trials were videorecorded for a detailed analysis of dogs’ behaviour. The floor of the sniffing room was washed after every training day to remove scents which may distract dogs.

The training was divided into a preliminary phase and 3 training phases:

The aim of the **preliminary phase** was to train dogs only to visit and sniff all stations in the lineup without any indication. Small pieces of odorous food were wrapped in cotton clothes and placed in jars in all 5 stations in the lineup. Another piece of food was thrown towards the lineup to persuade the dog to approach the lineup. If the dog approached and sniffed the station, the handler took quickly the jar from the station and rewarded the dog with a piece of food from hand, simulating the reward dropping out of the jar. Depending on the dog’s motivation to sniff spontaneously, usually no more than 5 trials per dog were necessary to train them to check all stations in a systematic way. The results of this phase were not analysed statistically.

In training phase I one station contained food scent, whereas the others 4 stations contained blank samples. Initially, in this phase the location of the target sample in the lineup was known to the handler during the first trials. The dog was given a piece of food to sniff (“taking air”) at the starting point approximately 2 m from the first station the lineup, and was encouraged to walk along the lineup and to sniff all stations. The starting point was separated from the lineup by a curtain, so, that the lineup was not visible either to the dog or to the handler before start. After sniffing the station with food scent, the dog was given the command “sit” or “down”. The kind of command / response was chosen by the handler depending on which kind of response was better performed by particular dogs during the basic obedience training. This reaction of the dog was thereafter considered as indication of the target scent in the lineup. Immediately after performing such behavior the experimenter activated the acoustic clicker signal and dogs were rewarded by the handler with a piece of food and praise. For each trial the location of the target sample was changed randomly. From the fourth trial on, the dog was given a chance to perform the sitting or laying down reaction spontaneously without command. It could sniff all stations up to two times during one trial and to decide about the indication by itself. If the dog missed the target sample after sniffing it for two times, the handler gave the command to the dog after it sniffed the target sample for the third time. When the dog had indicated the target sample correctly without command in three consecutive trials, the location of the target sample was no more known to the handler to avoid unconscious giving cues to the dog. Since then, the location of the target sample was only known to the experimenter who activated the clicker after correct indication of the dog. If the dog after some spontaneous indications again did not performed the trained sitting or lying down response and missed the target sample in 3 consecutive trials, the handler was informed again where the target samples had been placed and he/she gave the

Table 1
Number of trials performed by particular dogs in consecutive training phases.

Training phase	BEX	ERA	ARA	ATO	POR	SIU	Total for phases
I	137	175	195	351	253	294	1405
II	246	264	319	295	254	288	1666
III	143	105	153	166	184	169	920
Total for dogs	526	544	667	812	691	715	3991

commands to the dog until it indicated spontaneously. The clicker was not activated after a false alarm. For a false alarm the handler did not reward the dog and the dog was mildly rebuked.

The criterion for a dog to pass to each next training phase was performing at least a total of 50 faultless trials without any commands at given phase of the training. As faultless only those trials were considered, during which exclusively a correct indication of the target sample with no false alarm and no hesitations took place.

In training phase II the food scent was withdrawn as a target sample and instead of this, a human scent was placed in one station as the target scent. The remaining 4 stations contained blank samples. The training procedure was the same as in the training phase I except that the handler did not know the location of the target sample from the very beginning of this training phase. In the case of more than three consecutive misses the handler was informed at which station in the lineup the target sample had been placed and dog was encouraged by a command to sit at the proper station.

In training phase III one target sample containing human scent was placed in randomly selected station and the remaining 4 stations contained decoy scent samples taken from different donors, approximately at the same time as the target scent to avoid the effect of different storage time. The procedure of the trials was the same as in the training phase II i.e. in the case of more than three consecutive misses (no indication of the target scent) the dog was encouraged by giving a command by the handler who was inform where the target sample is placed, to motivate the dog for further work. If a dog made two false alarms within a trial before indicating correctly or sniffed all samples in the lineup for three times without indicating any of them, it was recalled by the handler to the starting position and new trial began.

The number of trials each dog performed in particular phases of the training is given in Table 1.

The way of sniffing the pattern scent sample before the start to search the lineup was scored using a five-point scale, according to the dog's interest for olfactory information and willingness to sniff and to cooperate with the handler:

Score 1. The dog violently rejects poking its nose into the jar with pattern scent and shows a strong avoidance behaviour. Sniffing is not possible even for a short time;

Score 2. The dog is not willing to poke its nose into the jar

with pattern scent but can be persuaded by holding its head and nose by the handler;

Score 3. The dog's nose must be directed into the jar and initially kept by the handler. Subsequently the dogs sniffs the sample in the jar without its head being kept by the handler

Score 4. The dog's nose must be slightly directed into the jar and subsequently the dogs sniffs on its own

Score 5. The dogs spontaneously pokes its nose into the jar and sniffs entirely without any assistance of the handler and even follows the jar with its nose.

All trials were videotaped and the following parameters of the dog's work in the scent lineup were analysed in consecutive phases of the training:

- way and duration of sniffing the pattern scent sample before start to search the lineup
- total number of stations in the lineup visited and sniffed before indication
- total searching time in the scent lineup before indication
- percentage of false alarms and misses

The time of sniffing the pattern sample before the start to search in the lineup was determined arbitrarily by the handler taking into account the sniffing style and enabling the dog to get enough olfactory information about the scent that was to be matched in the lineup.

The total searching time in the lineup was measured from the start, immediately after sniffing the pattern sample on, till the dog had indicated one of the samples in the lineup. When the dog sniffed all stations three times but failed to indicate any of them, the handler was instructed not to allow the dog to search any longer and new trial began.

For statistical analysis the three-way ANOVA with the following linear model was applied: $Y_{ijkl} = \mu + D_i + T_j + P_k + e_{ijkl}$ where:

D_i - effect of individual dog,

T_j - effect of the outcome of the trial (correct trial, false alarm, miss),

P_k - effect of the training phase,

e_{ijkl} - error

The ANOVA and Duncan test were used to assess differences in sniffing score, sniffing time, searching time and number of stations visited and sniffed. The data on sniffing score and number of stations have been transformed logarithmically prior to the ANOVA. For differences in false alarms and misses between dogs and between training

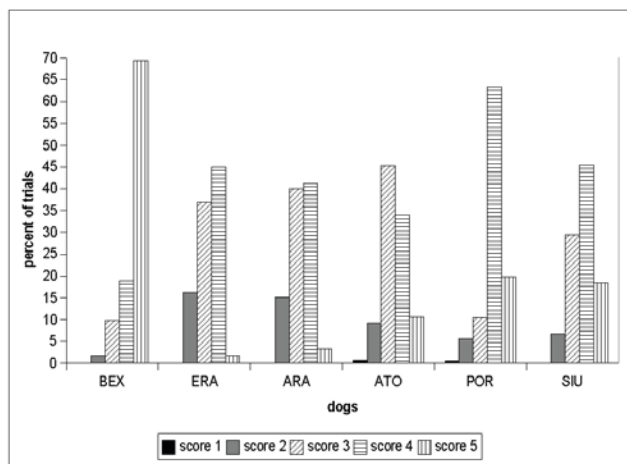


Figure 1. Styles of sniffing the pattern sample in particular dogs during training phase I (in %) Differences between dogs and between phases significant ($P < 0.001$).

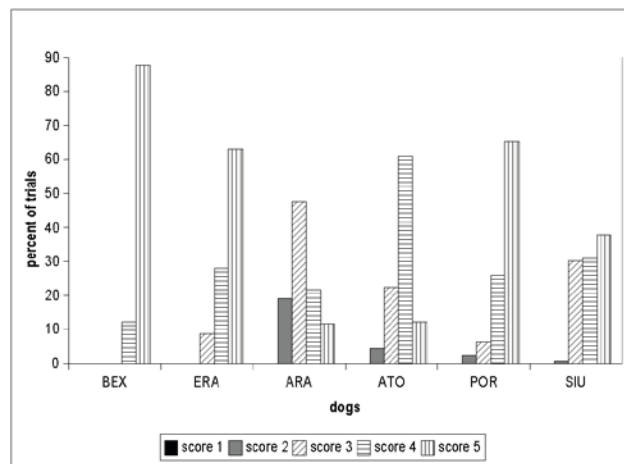


Figure 2. Styles of sniffing the pattern sample in particular dogs during training phase II (in %) Differences between dogs and between phases significant ($P < 0.001$).

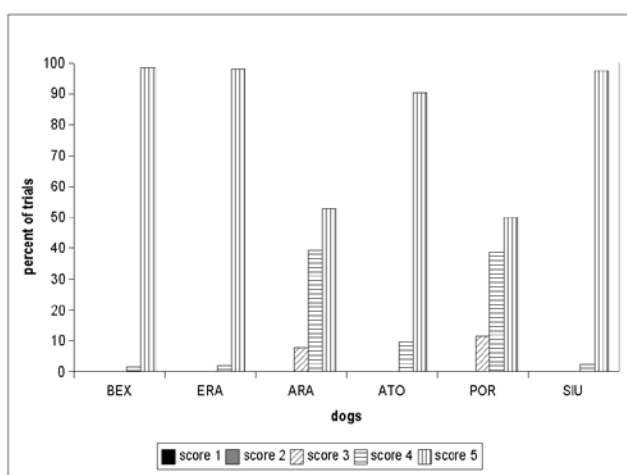


Figure 3. Styles of sniffing the pattern sample in particular dogs during training phase III (in %) Differences between dogs and between phases significant ($P < 0.001$).

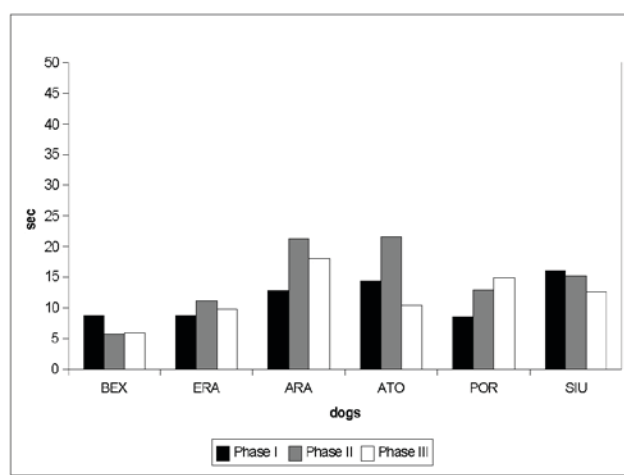


Figure 4. Mean sniffing time (sec) at the starting position. Differences between dogs and between phases significant ($P < 0.001$).

phases the Chi-square test was used. Rank correlation coefficients were calculated between the parameters of dog's work in the lineup.

Results

Dogs differ significantly ($P < 0.001$) in their scores for sniffing style at the starting position and there was a significant ($P < 0.001$) progress in the sniffing styles in consecutive phases of the training (Figs. 1-3). However, only three dogs (BEX, ERA, SIU) sniffed almost ideally in the final training phase III (>90% of sniffings with score 5) and during that phase three dogs, especially ARA and POR needed still some handler's assistance in sniffing at the starting position (Fig. 3). Mean sniffing time at the starting position differed significantly between dogs in all training phases and ranged from 5.7 to 21.6 sec showing no clear tendency, although the differences between consecutive training phases were significant ($P < 0.001$, Fig. 4).

The mean time of sniffing the stations and searching for the target sample ranged from 6.4 to 23.7 sec and was significantly different between particular dogs ($P < 0.001$). In phase I the searching time tended to be shorter than in phases II and III although this difference was non-significant (Fig. 5).

The mean number of stations visited and sniffed in the lineup differed significantly in particular dogs and between training phases, ranging from 3.5 to 6.9 and tended to increase in consecutive training phases (Fig. 6).

Percent of false alarms did not differ in particular dogs in phase I but the differences between dogs in phases II and III were significant ($P < 0.001$). Also, differences between pooled results for dogs in particular phases were significant ($P < 0.001$, Fig. 7).

Percent of false negative results (misses) was generally lower than of false positive and differences between dogs were less significant ($P < 0.05$ in phase I, $P < 0.01$ in phase II and non-significant in phase III). The differences between pooled results for dogs in particular phases were significant ($P < 0.001$, Fig. 8). There was a tendency for

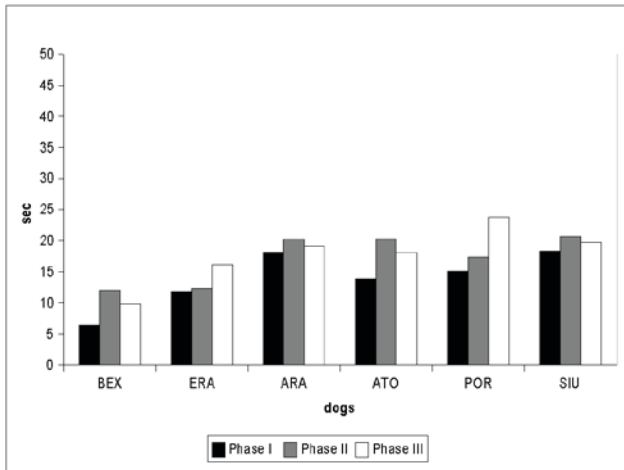


Figure 5. Mean time (sec) of sniffing stations and searching for the target sample in the lineup by dogs. Differences between dogs and between phases significant ($P < 0.001$).

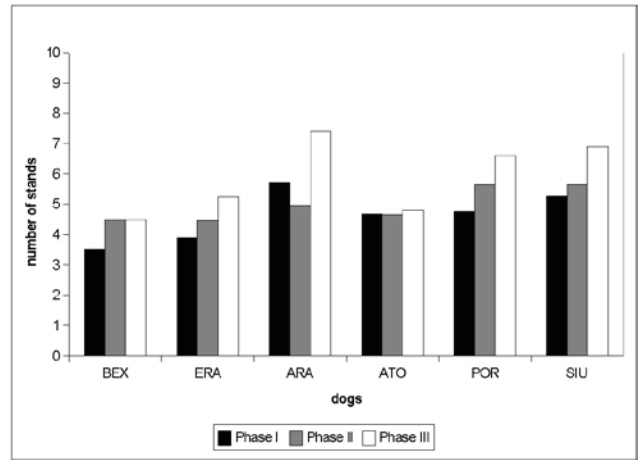


Figure 6. Mean number of stations visited and sniffed in the lineup during searching in the lineup. Differences between dogs significant ($P < 0.001$), and between phases significant ($P < 0.001$).

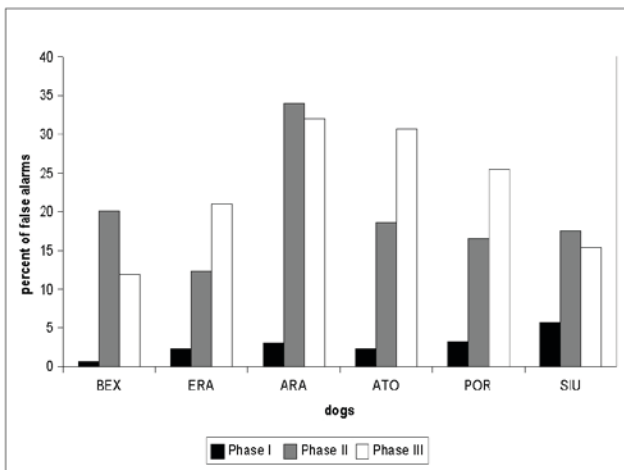


Figure 7. Percent of false positive indications by dogs in consecutive training phases. Differences between dogs in phases II and III ($P < 0.001$), Differences between phases significant ($P < 0.001$).

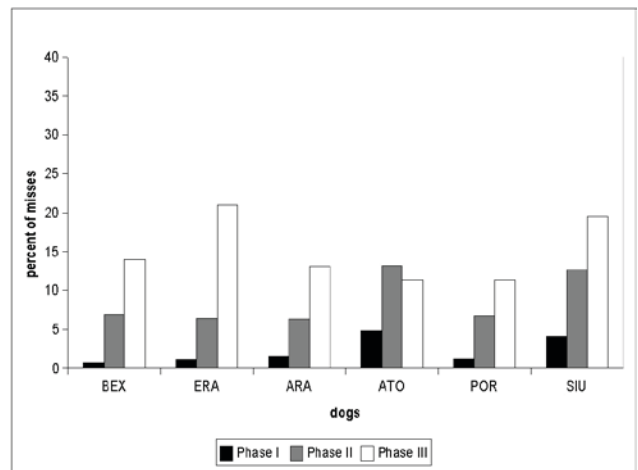


Figure 8. Percent of false negative indications (misses) by dogs in consecutive training phases. Differences between dogs in phase I ($P < 0.05$), in phase II ($P < 0.01$), in phase III non-significant, Differences between phases ($P < 0.001$).

the percentage of misses to increase in consecutive training phases (Fig. 8).

In Table 2 dogs' searching parameters were compared in trials which resulted in correct indications vs. false positive and false negative ones. The trials which resulted in correct indications did not differ significantly in their score for the sniffing style at the starting position from those that resulted in false alarms but they were significantly lower scored than trials resulted in misses (Table 2). The sniffing of the pattern sample took significantly shorter in correct trials as compared to trials resulted in false alarms but was non-significantly longer than in trails with misses (Table 2). Also, the searching time of the lineup was significantly shorter is correct trails compared to both false positive and false negative trials (Table 2).

The mean number of stations visited and sniffed during searching did not differ significantly in correct vs. false positive trials but during the trials which resulted in misses, the mean number of stations visited and sniffed during

searching was significantly higher ($P < 0.001$, Table 2).

The rank correlation coefficients between parameters of dog's work in the lineup were mostly non-significant due to a small number of dogs available ($n = 6$, Table 3). Relatively high and significant correlation coefficients have been found between the time of sniffing the pattern sample and score for sniffing style ($r_s = -0.98$, $P < 0.001$) and between the time of searching in the lineup and the mean number of stations visited and sniffed ($r_s = 0.98$, $P < 0.001$), as well as between percentage of false positive and false negative indications ($r_s = -0.88$, $P < 0.05$). The correlation between the time of sniffing the pattern sample and the searching time in the lineup was also relatively high ($r_s = 0.83$, $P < 0.05$).

Discussion

According to the training instruction for the police dogs, the training in the scent lineup takes on average 110 days, about one hour daily (Rojek, 1998). However, no

Table 2
Differences in searching behaviour between trials with correct, false positive and false negative indications.

	(1) Trials with correct indications	(2) Trials with false positive indications	(3) Trials with misses	Statistical significance of differences (Duncan test)
Mean score and SD for the sniffing style at the starting point	4.05 ± 0.96	4.09 ± 1.00	4.38 ± 0.92	(1) - (2) ns (1) - (3) *** (2) - (3) ***
Mean time (sec) and SD of sniffing the pattern sample	13.6 ± 11.1	15.5 ± 12.2	12.9 ± 8.4	(1) - (2) *** (1) - (3) ns (2) - (3) **
Mean time (sec) and SD of searching the target sample in the lineup	13.4 ± 12.1	28.9 ± 20.8	23.2 ± 17.1	(1) - (2) *** (1) - (3) *** (2) - (3) ***
Mean number and SD of stations sniffed during searching	4.84 ± 3.21	4.88 ± 3.19	7.73 ± 3.79	(1) - (2) ns (1) - (3) *** (2) - (3) ***

Table 3
Rank correlation coefficients between parameters of dog's work in the lineup.

Parameter No	2	3	4	5	6
1. Time of sniffing the pattern sample***	0.83 *	- 0.98	0.14	- 0.37	0.78
2. Time of searching and sniffing the stations		-0.78	0.09	- 0.43	0.98***
3. Mean score for style of sniffing the pattern sample			- 0.09	0.26	- 0.73
4. Percent of false positive indications*				- 0.88	- 0.06
5. Percent of false negative indications (misses)					- 0.32
6. Mean number of stations visited and sniffed during searching					

* P<0.05

*** P<0.001

precise criteria were given as to the dog's performance to be fulfilled to pass to the next training phase. In the present experiment the criterion of 50 faultless trials without any assistance of the handler made the entire training much longer (approximately 250 days) during which a total of 3991 tests (round of dogs in the lineup) were conducted. The total number of trials performed by particular dogs was different and depended on the motivation and readiness of dogs for work and necessity to make some more trials to achieve a relatively equal proficiency level of all dogs.

During sniffing the dog should gain enough olfactory information about the kind of scent molecules collected on the cotton clothes and should encode this information in dog's olfactory working memory. Dogs should be able to match this scent to one of the scents in the lineup and it should only distinguish the scent samples on the base of the individual component of human scent. The sniffing of the pattern sample ("taking air") before the start to search for the matching target sample in the lineup, is believed to be an important part of the identification procedure, since operational police dogs have sometimes to identify in subsequent trials on one testing day the scents of different persons (e.g. during so called control trials). The sniffing of pattern samples may become stressful to some dogs if they are not willing to sniff spontaneously and show no interest in the scent. Some dogs may be reluctant to sniff the cotton cloth placed in a jar with a too narrow opening.

Using force to put dog's nose into the jar may result in negative conditioning for the sniffing procedure and the dog will not gain olfactory information about the sample but will try to avoid the unpleasant situation. The handler should encourage the dog to poke its nose into the jar by pretending that something interesting for the dog (e.g. a piece of food) is in the jar or is just being put into the jar. The handler should observe carefully the dog during sniffing the pattern sample and should be able to distinguish true sniffing from merely holding the nose in the jar and breathing. The scoring system applied in the present study seems to be a good way for qualitative assessment of the dogs' willingness to sniff the scent samples. Dogs get usually enough olfactory information about an object after a short sniffing. According to Thesen et al. (1993) dogs are able to determine direction of human footsteps during olfactory tracing by sniffing only 3-5 footprints and the deciding phase lasts 3-5 sec. Hepper & Wells (2005) found that dogs were able to determine direction from 5 footsteps but not from 3 footsteps and the authors calculated that it takes even 1-2 sec for the odour information in footsteps to change, to provide discernible information used by dogs to determine direction of tracking.

Sniffing the pattern sample should be neither too short, nor too long in time. A too long sniffing the same substance (scent molecules) may involve adaptation of olfactory receptors in olfactory epithelium and neurons in the

olfactory bulb which results in a temporary decrease of the sensitivity of the dog's sense of smell to this substance.

In the present study the style of sniffing the pattern sample was negatively and significantly correlated with the time of sniffing it. This could be explained by the handler's trying to compensate poor sniffing style of the dog by prolongation of the sniffing. Comparison of trials resulting in correct indications vs. false alarms or misses and correlation coefficients calculated on the base of individual dogs, were not always consistent. For example the differences in the sniffing scores have shown that the sniffing style has no significant effect on the percentage of false alarms. The style of sniffing the pattern sample was negatively and relatively highly correlated with the mean number of stations visited which may mean that a better sniffing style makes the dog's decision as to the choice of the matching sample in the lineup easier, however, the correctness of this choice does not necessarily improve. A longer mean time of sniffing the pattern sample was found for trials resulting in false alarms but this was not confirmed by a significant rank correlations coefficients indicating that dogs which sniffed the pattern sample longer, committed more false alarms. On the other hand the time of sniffing the pattern sample was not significantly different in correct trials vs trials resulted in misses.

The time of searching in the lineup depends on the walking speed of dogs, distractions by other stimuli in the sniffing room and the number of stations checked. The trials resulting in correct indications were shorter in time. This could be explained by a possibility that a dog, when searching for a too long time, could "forget" the scent which it has to match, either due to being distracted by other stimuli in the room or due to being undecided and checking several times the same stations in the lineup.

A negative and significant correlation ($r_s = -0.88$) between percentage of false positive and false negative indications may inform that dogs which make many misses during trials as a consequence would demonstrate less false alarms. It could be therefore concluded that a dog should be able to refrain from any indication during a trial, if it is not sure which of the scents in the lineup is the matching one and has to be indicated.

The way of checking and sniffing the stations in the lineup is crucial for the identification procedure. There are no standards how many stations and target samples should be in the scent lineup. The higher number of stations and the lower number of targets in the lineup – the lower probability that a dog would indicate correctly by chance. In the canine identification procedure applied by Polish police the most typical is a scent lineup of 5 stations and one target station (Gawkowski 2000). In Dutch police usually two parallel scent lineups of 6 or 7 station were applied (Schoon 1996, 1998). A multiple choice apparatus in form of circular stand with variable number of arms

(stations) progressing from 6 to 12, depending on the dog's proficiency, was applied in a training program for filter-search mine detection dogs (Fjellanger et al. 2002). It is important that the dog sniffs all the station in the lineup since omitting some stations increases the probability that the sample is indicated correctly by chance (Jezierski, et al. 2003). Comparing systematically several scents (stations) during one trial may be too difficult for some dogs. Taking this into account, Schoon (1997) proposed a new experimental design where an odd-even paradigm was followed and care was taken to meet forensic prerequisites in the experimental setup. In the latter experiment the dogs sniffed only two stations one of them (randomly chosen) containing the target sample and the other was blank. The author came to the conclusion that the level of matching "even" scents was comparable but the level of non-matching in "odd" comparison was substantially higher in the new design. Although the scent identification following an "odd-even" paradigm seemed to be more reliable than the customary design, Schoon (1997) expressed an opinion that introducing this new design would require significant changes in attitude and working conditions of the police, and in fact this design has never been introduced into practice.

Another important aspects of the information-seeking behaviour of dogs during searching of the lineup, which was not analyzed statistically but must be mentioned, is an increasing routine of dogs during progressing operant conditioning. After a dog has learned the procedure, it can increasingly try to use another cues and senses to locate the target sample in the lineup. The dog can leave some saliva on the target sample during sniffing and can use it as a cue if the same jar with the cotton cloth or the cotton cloth is repeatedly used in consecutive trials. For that reason all samples in the lineup should have identical appearance and should not have any characteristic details which could be used by the dog to distinguish this sample visually. The location of the target sample in particular stations of the lineup should be changed quasi-randomly to prevent a conditioning of the dog to indicate more often at one particular station. A full randomization in changing the location of the target sample is not advisable since some dogs may demonstrate a tendency to indicate more often at one particular station (e.g. the first or the last one). If, due to full randomization, the target samples would be placed several times again and again at the same station, which is already preferred by the dog, the existing tendency of the dog to make more false alarms at this station would be reinforced. Therefore the location of the target sample for the next trial should be always carefully chosen by the experimenter.

In the present paper for the sake of simplicity, the "double-blind" or "zero" trails which are normally used to check the reliability of dogs' indications, were not analyzed.

Another potential problem could be the so called "clever Hans effect" i.e. unconscious giving by the handler some cues to the dog where at which station the dog's indication is expected (Gawkowski 2000). To avoid this unconscious communication between the handler and dog during searching, the location of the target sample in the lineup should be unknown to the handler, except for naive dogs during the very first phase of the training. The experimenter who knows the location on the target sample in the lineup, should be invisible (hidden) to the dog during searching. Dogs are exceptionally well responding to human pointing gestures when finding food or toy at a place that is indicated by a human (Soproni et al. 2001, 2002). A routine at dog's work in the scent lineup may involve additional forms of information-seeking behaviour e.g. observing and anticipating unconscious reactions and gestures of the handler. In particular, rewarding the dog for correct indication must be precisely timed (in few seconds after the clicker sound). The way of holding hand with the reward must be such that no dog's attention is drawn or distraction is caused before the dog precisely sniffs the stations in the lineup and unequivocally indicates.

Since the trials are repeated several times on a day, and the location of the target sample in the lineup is changed quasi-randomly the dog should be prevented to see where the new location is. The searching in the lineup involves resolving the problem of a hidden object. The dog may also use spatial information where the target sample was hidden during the previous trial. Studies of Fiset et al. (2000) have shown that the processes used by dogs to encode the spatial position of a hidden object are highly flexible; these processes in dogs are primarily based on egocentric spatial information (according to animal's own spatial coordinates) but if the experimental situation precludes a successful use of egocentric spatial information, dogs also do encode allocentric spatial information (referring to the relationships between a target location and the objects surrounding it).

In conclusion, this study shows that the parameters of information-seeking behaviour of sniffer dogs during olfactory examination of scent samples using the scent lineup, may have impact on the percentage of mistakes (false alarms and misses) made by dogs. However, the reliability and quality of canine identification of humans on the base of scent depends primarily on individual dog's predispositions involving trainability, olfactory acuity, ability to focus on the search in the lineup, motivation for sniffing and interest in getting a reward for a correct indication. A very low percentage of mistakes made by dogs is crucial for the validity of the canine detection from the point of view of forensic application.

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