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Investigation Police Dog Olfactory Acuity Through: Comparing Various Dog Breeds, Previous Training Experiences and Searching Site on the Detection of Narcotics

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Abstract | Due to the high olfaction acuity of dogs, they are used to detect the cryptic or hidden objects like explosives and narcotics. The current study was conducted to evaluate the impact of dog breeds, searching site and previous training experiences on the dogs' detection performance for narcotics. One hundred and sixty-five purebred dogs from four breeds, *German shepherd* (n=46), *Labrador retriever* (n=41), *Belgin malinois* (n=40), and *Rotweiller* (n=38) were utilized. Dogs have examined shortly before the first certificate for the operational efficiency, during police certification exams and also, during an annual recertification exam assuring proficiency. The obtained results demonstrated that *Labrador retriever* was the highest in correct alert and the lowest in false alert, miss trails, and passes without indication. Dogs performed better during first police exams for certification than during the final stage of training and annual recertification. A significantly higher proportion of correct alert and a lower false alert were recorded inside the cars in comparison to other searching sites. Conclusively, *Labrador retriever* breed was the superior breed in narcotics detection and were easily found inside cars, while and best detection performance was for dogs during first police certification exams.

Keywords | Detection, Dogs breed, Narcotics, Experience, Searching site

INTRODUCTION

Domestic dogs are widely used in odor detection with great success in cancer detection in the medical field (Bijland et al., 2013; Gadbois and Reeve, 2014), explosives and drug disclosure in the armed and police forces (Gazit and Terkel, 2003; Ensminger, 2012; Jezierski et al., 2014), and semen stains for crime scenes (van Dam et al., 2019). It has been proven difficult to train many selected breeds for their odor capabilities, especially scent-hounds (Ley et al., 2009; Turcsán et al., 2011). Olfactory acuity may be affected by genetic differences in olfactory receptors or anatomical variations in ear and nose shape. Bloodhounds have 300 million odor receptor cells, more than any other breed (Beebe et al., 2016; Lazarowski et al., 2020), and are

considered to have the greatest olfactory acuity. Craven et al. (2010) and Abney (2009), reviewed that mesocephalic breeds (i.e. elongated noses) have more olfactory receptors, enabling them to distinguish and retain more scents. The most common species used in detection are *Labrador retrievers, German shepherd* dogs and *Belgian shepherds* due to their drive and high ability to train. In Japan, the most prevalent narcotic detection breed is *Labrador retriever* dogs (Maejima et al., 2007), while the commonly selected breeds for drug detection in Poland are *Labrador Retrievers, German Shepherds, Terriers* and *English Springer Spaniels* (Jezierski et al., 2014). In the United Kingdom, the most popular breeds used for narcotics and explosive detection, are *English Springer Spaniels, Labrador Retrievers,* and *Crossbreed* (Rooney and BradShaw, 2004).

Dogs have been used for more than 30 different detection tasks to find drugs because of their highly versatile detection abilities (Lorenzo et al., 2003; Hall et al., 2014). There is no standardized run for assessing canine olfactory capability (Polgár et al., 2016). The detection efficacy of the dogs can be evaluated through both detection speed and accuracy. The detection rapidity is important as the delayed in response can lower the speed of the process, also, too quick reaction may lead to a sequel as setting off a tripwire. Detecting accuracy includes recording correct alert, false indication, right rejections, and misses. The accuracy can be assessed by two essential components which are sensitivity (i.e. ratio of alerts to misses), and specificity (i.e. ratio of right rejections to wrong alerts).

Drug detectors dogs are exercised to discover the most frequently utilized and trafficked drugs and are rarely specialized on certain drugs (Jezierski et al., 2014). Generally, the canine is trained to distinguish the strong odor drugs like Hashish and Marijuana. Within the drug detection programs, thirty percent of dogs that share drug detection training are working detection dogs (Maejima et al., 2007; Hall et al., 2013). Indeed, the poor performance on odor detection can be avoided through a simple olfactory assessment that gives the trainer chance to choose the best individuals from groups prior to the beginning of training that may be of considerable practical use. Besides the poor performance in odor detection, temperament and training issues could have a minor role in those failures. Moreover, the dog's welfare is valuable to the training and formation of a drug detection dog (Jantorno et al., 2020)

The present study was undertaken to assess the effect of dogs' breed, searching site, and training experience on the detection performance of narcotics.

MATERIALS AND METHODS

Experimental narcotics detection tests were carried out in security and guarding dog training center, belonging to the Ministry of Interior, Cairo, Egypt. One hundred and sixty-five purebred dogs from four breeds, *German Shepherd* (n=46), *Labrador retriever* (n=41), *Rotweiller* (n=38), and *Belgian malinois* (n=40) were utilized. Dogs were examined shortly prior to the first certificate for operational efficiency, during police certification exams and also during an annual recertification exam assuring proficiency. All dogs were fully trained under Egyptian police training protocols, including those that were in the pre-certification stage but had not formally passed the examination of operational proficiency. Narcotics samples used in this test weight 10-15 g consisting of marijuana, hashish, amphetamine, heroin and cocaine which were concealed nearly an hour before being inserted for searching either in rooms known

to the dogs or unknown ones to them, also inside and outside cars, outdoors and in line up of luggage. During each test, only one specimen was used and placed in an unclosed plastic bag in the search area.

The dog were allowed to move independently (off-leash) during search except when search outside the cars, they were on leashes and handlers were permitted to promote dogs to search in specific sites. A video camera was used to record all tests. When the dog indicated the site of narcotics by scratching it this is called "active = correct alert". Another manner of indication, sitting or lying down in front of the site, which was considered "passive = false alert". The handler informed the experimenter confirming the correctness of the dog's indication by saying "ok" while the experimenter's face wasn't seen by the dog because the experimenter was holding a video camera and not interrupt to dog's alert. For correct indication, the dog was instantly rewarded by throwing its favorite toy to retrieve while the dog wasn't rewarded and mildly rebuked by saying "no" for false indication.

Parameters of a police dog for detection of narcotics were recorded whereas the following:
Number of correct alerts (Correct alert), number of false alerts (False alert), the number of miss trail: (if the dog wasn't able to indicate the site of the narcotics samples within 10 minutes), (Miss trail). The number of another chance trail: If the dog made a false alert and given another chance to get a correct indication (Chance for the trail). The number of passes of dog in distance lesser than one meter closer from the sample without indication (passes without indication).

Figure 1: Illustrated dog search in different sites: (A) line up of luggage, (B) outdoors, (C and D) outside cars.

No more than two searching tests were done for any dog on one day. If we had to perform 2 searching tests on the same day for a certain dog, the second test carried out in another room. The dogs (<10) tested on the same day, same room, and the drug sample was concealed in the same place for all dogs. The dogs with their handlers stayed in another building until they were asked to come for trails.

STATISTICAL ANALYSIS

Data were analyzed by one way-ANOVA and Duncan multiple range post hoc tests using the SPSS 16.0 computer program was performed to compare between means. Data were expressed as mean ± SE with P < 0.05 was considered statistically significant.

RESULTS AND DISCUSSION

The obtained results revealed that there was a significant effect of dogs' breeds on their detection performance. *Labrador retriever* breed recorded the highest proportion of correct alert (86.04±0.46) and the lowest results of false alert, miss trails, chances of trails, and passes without indication (10.07±0.49, 7.02±0.38, 6.02±0.35 and 2.07±0.29 respectively). On the other hand, *Rottweiler* breed showed the lowest correct alert proportion (55.15± 2.01) and the highest for the false alert, miss trails, chances of trails and passes without indication as shown in Table 1.

Table 2 represented the effect of searching site on the detection performance of dogs. It was revealed that all searching site had a significant effect on all detection parameters studied. Based on the higher proportion of correct alert and the lower of false alert, the indication of narcotics was the easiest and more accurate inside cars and hardest in the lineup of luggage. Significantly higher miss detection trails was recorded at the lineup of luggage and so searching was often ended by miss and needed more chances for dogs to be able to alert to drugs. The numbers of passes without indication of narcotics on a distance < 1 m far were the highest for the outdoor and the lowest at the lineup of luggage.

The correct indication was significantly lower during the final stage of training before examinations for certification (51.31±1.72). However, the false alert proportion and miss trail were significantly higher in the final stage of training before examinations for certification (Table 3). Dogs passed significantly more times to detect drugs hidden at a distance less than one meter before the examination than during examination and annual recertification (Table 3).

A canine's superior sense of smell gives them the ability to not only detect miniscule odors undetectable by human but also to distinguish these odors from an array of distracting and/or more powerful odors. However, in this study their narcotics detecting ability and accuracy significantly differed between dog breeds as shown in Table 1. *Labrador retriever* dogs were recorded to be superior in comparison to *Belgian malinois*, *German shepherd* and *Rottweiler* breeds. In which, the highest percentage of correct alert was recorded by *Labrador retriever* dogs while the *Rottweiler* was the lowest. Based on a more false alert, miss trails, chances given to the dog to indicate narcotics and the number of passes to detect the narcotic hidden on a distance <1m *Rottweiler* dogs were the worst breed the in detection narcotic drugs. These findings were confirmed by (Jezierski et al., 2014) who stated a difference in the performance of breeds regarding the detection of narcotics. These observed differences in detection performance between dog breeds may be regarded to their behavioral differences (Slabbert and Odendaal, 1999; Svartberg and Forkman, 2002; Rooney et al., 2007; Sinn et al., 2010). These behavioral traits should be investigated to improve the dog welfare, training and management (McGaritty et al., 2016). Particular physical traits (such as threshold of sensitivity to low concentrations of odor) and behavioral are essential for selecting the detection dogs, so certain breeds are being chosen for detection tasks (Jamieson et al., 2017). And also, they are bred for specific personality traits (McGaritty et al., 2016). A detection dog must have the ability to work cooperatively with humans (Beebe et al., 2016), which it is invaluable for a detection dog (Gácsi et al., 2009; Hurt and Smith, 2009), and follow auditory and visual cues (Beebe et al., 2016). However, the behavior and performance variations among dogs' breeds can be a controversial topic (Fadel et al., 2016). Dogs' suitability for drug and explosives detection may vary and altered over the long term owing to the differences in genetic selection and present breeding directions in certain breeds (Adamkiewicz et al., 2013).

The suitability of specific breeds for detection tasks is important when purchasing dogs for training and operational work. Therefore, the priority of certain breeds for detection in countries varies depending on traditional breed selection, availability, and current views (Jezierski et al., 2014).

Labrador retrievers are the most popular dog for narcotic detection in many countries (Maejima et al., 2007) although, they are generally known for their high food motivation. The too-high motive for food is unlike in working dogs because they may be distracted when searching (Adamkiewicz et al., 2013). On the other hand, Jezierski et al. (2014) reported that dog testing during police drug detection in Poland, revealed that *German Shepherds* recorded the highest accuracy and efficacy in comparison to other breeds as *Labrador Retrievers, English Cocker Spaniels,* and *Terriers. Terriers* had the longest

Table 1: The effect of dog breeds on the training detector dog performance (number mean ±SE).

Breeds	Number	Correct alert	False alert	Miss trail	Chances of trails	Passes without indication
Labrador retriever	41	86.04±0.46[a]	10.07±0.49[d]	7.02±0.38[d]	6.02±0.35[d]	2.07±0.29[d]
Belgain malinois	40	80.05±0.69[b]	13.12±0.57[c]	9.25±0.65[c]	8.05±0.42[c]	4.32±0.39[c]
German shepherd	46	64.15±1.13[c]	23.23±1.16[b]	12.34±0.62[b]	10.08±0.52[b]	7.11±0.34[b]
Rottweiler	38	55.15±2.01[d]	30.71±1.4[a]	19.15±1.2[a]	15.39±0.9[a]	9.92±0.79[a]

Mean with different superscripts in each columns are significant at P≤0.05.

Table 2: The effect of searching site on the training detector dog performance (number mean ±SE).

Searching site	Correct alert	False alert	Miss trail	Chances of trails	Passes without indication
Room known to dog	68.3±1.45[b]	28.26±1.29[c]	4.23±0.9[c]	4±0.87[c]	2.96±0.49[ab]
Room unknown to dog	54.2±1.63[c]	34±1.57[b]	6.3±0.74[bc]	5.23±0.77[bc]	3.36±0.44[a]
Outdoors	52.06±1.34[c]	35.96±1.55[b]	8.10±0.82[b]	7.13±0.72[b]	3.76±0.42[a]
Outside cars	55.03±1.34[c]	32.3±1.37[b]	5.43±0.58[c]	6.23±0.70[b]	2.73±0.43[ab]
Inside cars	73.26±2.1[a]	20.06±0.73[d]	3.13±0.56[d]	1.13±0.21[d]	3.1±0.4[ab]
Line up of luggage	21.1±0.88[d]	45.2±1.35[a]	12.86±0.61[a]	13.03±0.53[a]	1.86±0.30[b]

Mean with different superscripts in each columns are significant at P≤0.05.

Table 3: The effect of dog training experience on the training detector dog performance (number mean ±SE).

Dog experience stage	Correct alert	False alert	Miss trail	Chances of trails	Passes without indication
Final training stage (before examination)	51.13±1.72[c]	10.2±0.65[a]	12.26±1.99[a]	2.3±0.41[b]	3.83±0.39[a]
During examination	68.16±1.60[a]	9.16±0.54[a]	5.13±0.37[b]	8.63±0.34[a]	2.06±0.35[b]
During annual recertification exam confirming proficiency	62±1.34[b]	6.26±0.27[b]	5.03±0.40[b]	7.76±0.65[a]	2.73±0.41[b]

Mean with different superscripts in each columns are significant at P≤0.05.

detection periods and the highest rates of false positives. Whilst, the small size of Terriers can be advantageous as allowing them to investigate confined areas despite their relatively poor accuracy rate.

Concerning the effect of searching site on narcotics detection performance of dogs represented in Table 2. The higher percentage of correct alert and lower false alerts was inside cars and vice versa in the lineup of luggage. Also, significantly higher miss trails was at the lineup of luggage and so dogs needed more chances to alert to the drugs.

While, the numbers of passes without indication trails to detect the narcotics on a distance < 1 m far were the highest at outdoor and the lowest at the lineup of luggage. These results may be attributed to high concentration of odor inside the car cabin as small space, so the odor may be distributed throughout this small space and become more concentrated, which resulted in a higher percent of alerts to the scent source, However, in the outside of cars, the air disturbance around the car may confuse the odor, resulting in more false alerts and more misses. On the other hand, Jezierski et al. (2014) found that the detection times were significantly lower in the lineups of luggage, while a lower correct alert proportion and higher false indications were

inside and outside cars. The true proportion of correct alerts and misses is impossible to be estimated as it is unknown whether the odorous substance exists or was already presented at the site of search. Moreover, the presence of external odor related to the target odor interrupted the detection performance of dogs especially if was in large amount (Waggoner et al., 1998). Also, motivation had some role in the detection performance of dogs as mentioned by Gazit et al. (2005) who indicated that detector dogs have motivation to search in sites that have been trained in and always can find a target odor and are rewarded versus clean locations where dogs cannot find the target scent.

Canine cognitive and learning ability have an important role in scent detection performance besides their olfactory acuity (Lit, 2009; Lit and Crawford, 2006; Jezierski et al., 2008, 2010).

Generally, experience plays a role in the behavior of animals. The results in Table 3 revealed that the trained dogs performed better (i.e. more correct alert and less false alert) during the formal examination than before examination and in the annual recertification. Dogs needed more chances to detect the narcotics during the final stage of training (before examination) than during examination

and annual recertification.

Also, they passed significantly more times to detect drugs at distance less than one meter before examination than during examination and annual recertification. These may be due to more effort and preparation are done by trainers or handlers prior to the test to enable their dogs to obtain the certificate, therefore, the more training lead to better detection performance in dogs. Also, the fewer training trails needed by dogs that have learned to distinguished more target odor from non-target odor (Williams et al., 1999; Macias and Furton, 2011). Williams and Johnston (2002) found that when dogs (with unspecified backgrounds) learned the distinction between one scent after another (up to 10 scents), there was no decrease in the number of scents they could discover nor an increase in false alerts. So, the optimum detection sensitivity and specificity had to be done if no target materials are untrained and still undetected, and no other substances are falsely detected by dogs. Also, it should be taken into consideration that the wrong alert and misses may not always be a dog error but may be due to human faults. Wrong alerts that resulted from insufficient training of dogs are due to the actions of handlers (Hunter, 2002; Gazit e al., 2005; Lit et al., 2011; Duranton and Horowitz, 2019; Jantorno et al., 2020), so dog's human-directed communitive behavior could affect individual experience (Marshall-Pescini et al., 2009). Moreover, Jezierski et al. (2014) proposed that handlers' stress may affect dogs' activity, when they understood that trials attempts were certification, the dogs made more wrong indication and so fewer true alerts and longer searching period.

CONCLUSIONS AND RECOMMENDATIONS

Labrador retriever breed was the superior breed in narcotics detection and were easily detected in the inside of cars and the best detection performance for the dog during police certification exams.

ACKNOWLEDGEMENT

AUTHOR'S CONTRIBUTION

All the authors contributed equally.

CONFLICT OF INTEREST

The authors have declared no conflict of interest.

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