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The Explosive Sniffer Dogs in Security Operations: An assessment of their Performance in Screening for Concealed Explosives

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Abstract

The screening for concealed explosives in security operation using explosive detection dogs (EDDs) is an event in series demonstrated by trained dogs in five stages: utilization of their specific knowledge for screening explosives; skills in detecting explosives, skills in locating explosives and their experience and time to screen for concealed explosives. In screening for concealed explosives, the EDDs demonstrate behavioral responses that alerts the handler on the stages of each dog performance in the praxis. The EDDs praxes have hardly been fully studied by an empirical method in assessing the performance in screening for concealed explosives.

This study assessed the five EDDs events through an observation method in a quasi – experimental settings. The results depicted a mean performance of 84 (84 %) in EDDs performance in responding to the words of command, 90 (90 %) in demonstrating responses in locating explosives, 80 (80 %) in demonstrating responses in locating concealed explosives and 66 (66%) in demonstrating responses attributed to their experience. A strong negative correlation (- .934, sig .000) was established between EDDs responses to the words of command and time taken by each dog in responding to words of commands. A coefficient of .857 (86.7 %) was achieved in inferring the sample performance to the EDDs population in responding to the words of commands. A significant negative correlation (-.638, sig .0470) was established in dogs demonstrating responses in detecting explosives against time taken. A reliability of 33.3 % in inferring this outcome to the population was established. An insignificant positive correlation (.571, sig .084) was established between the EDDs demonstrating alert responses for locating concealed explosives with time taken in their performance. A significant strong negative correlation (- .739, sig 0.013) was established between the dogs' experience and time taken to identifying five samples

of concealed explosives with a reliability of 50.6 % (R = .506) in inferring this outcome to the EDDs.

Key words: Explosives; Detection, locating; Screening; Responses.

Introduction

Explosive sniffer dogs (EDDs) are widely used in screening for concealed explosives in security operation (Lieu, 2014; Wilson, 2006; Krauss, 2015; Furton, 2010; Akram and Akram; 2014; Mannik, 2011; Fisher, 2013; Safers tein, 2007; Chan et al, 2016; Srinivasan, 2018). Studies have described that they are reliable, efficient, and cost effective in screening for concealed explosives (Philips, 1971; Gazit,2003; Oh, et al, 2011; Lee et al, 2012; Concha et al, 2014; Gadbois, 2014; Overton, 2017). However, their performance in an empirical method has been understudied (Delfino, 2014; Verma, 2015). The few literatures available in this field are narratives that depicts their performance in heroic feats (Hart, 2000; Ensminger, 2012; Rooney,2014). It is against this background that this research was conducted to assess their performance through an empirical method.

In assessing the EDDs performance, an observation method in a quasi-experimental setting was employed in studying their performance in screening for concealed explosives. Five components employed by the EDDs in a working scenario were adopted as variables in this study: the EDDs assessment to responses for five words of commands, five behavioural responses demonstrated by the dogs while detecting for concealed explosives, five responses demonstrated by the dogs in locating explosives, their ability to identify a sample of five different concealed explosives and an assessment of time taken in demonstrating each adopted variable. An observation checklist was used to collect the EDDs data. The data for each variable was analysed and used in calculating the EDDs mean performance for the five variables studied. Pearson's correlation coefficient was used in measuring each variables correlation while linear regression model was used to determine each variables coefficient against time taken in screening for concealed explosives.

Background to the Study

The EDDs are specially trained to screen for concealed explosives in security operations (Loeb, 1974; Galeg, 1986; Eunson, 2012; Kaminski and Nitzschner, 2013; Buck, 2002; Leah and Osthaus, 2018). The screening for concealed explosives is a five event in a series comprising of the EDDs use of: specific knowledge, skills for detecting and identifying the location of concealed explosives, their experience in a working scenario and use of time in each event while screening for explosives (Furton, 2010; Miklosi etal, 2016 ; Landsberg etal, 2013; Gazit,2003; Gazit,2005; Cental Intelligence Agency CIA, 2015; Philips, 1971; Handy, 1961; Brown, 2005; Archey, 2006; Johnson,1999; Furton, 2010). There are ranges of factors that influences the K-9s performance in a working scenario (Gazit, 2003; Gazit,2005; Harper, 2005; Kopp, 2008; Concha, et al, 2014; Ostmark et al, 2012; Suddeth, 2017). These studies depict that the method of screening explosives by use of EDDs is a recent phenomenon that has not been fully investigated by an empirical

method, their literatures are scarce and the few literatures available depicts their performance in heroic feats.

Problem Statement

Many studies have demonstrated that the EDDs are not infallible in screening for concealed explosives (Concha, et al; 2013; Gazit, 2003; Gazit, 2005). Their fallibilities that render them vulnerable in a working scenario are occasioned by their ontogeny, epistemology of the praxes and exogenous variables (Habib, 2003; Townsend, 2003; Bach & McLean; 2003; Gazit, 2003; Gazit, 2005; Mudford et al, 2009). Their performance in an empirical method in cognizant with these variables has been understudied (Delfino, 2014; Verma, 2015). The few literatures also available in this field are narratives that depicts their performance in heroic feats (Hart, 2000; Ensminger, 2012; Rooney,2014). Delfino (2014) posit that:

> *"Although there is much that is good in modern science, misunderstanding its proper role in our intellectual and everyday lives is a danger, and the cause of much decline and confusion in the West. Unfortunately, some famous scientists have misused discoveries in science to promote the reductionism, materialism, and secularism we find today in the West. For example, scientists such as Richard Dawkins and Sam Harris have targeted general audiences with the message that we should look to modern science to treat questions about ethics and the existence of God. this way, for many, scientists have become the new high priests of our age—replacing the theologians, philosophers, and poets of prior ages, a situation in dire need for cultural renewal", (Delfino, 2014;486).*

The Research Methodology

An observation method in a quasi-experimental setting was used in studying the five variables assumed to have a significant influence in the EDDs praxes. A sample size of 10 K-9s, randomly chosen from a sampling frame of 15 EEDs available for this study were observed in their praxis. Quantitative data were collected by use of an observation checklist and analysed in describing the sample mean performance and determining the variables correlations and coefficient in the EDDs praxes.

The Quasi- Experimental Settings

Four outdoor quasi - experiments were conducted in observing and assessing the performance of the EDDs in security operations. The quasi - experiments involved: assessing the EDDs responses to five words of commands; assessing behavioural responses made by the EDDs in detecting concealed explosives; assessing the EDDs responses in locating for concealed explosives, investigating the EDDs experience in identifying a sample of five concealed explosives and an assessment of time taken in demonstrating behavioural responses for each variable observed.

The words of command responses

This experiment was conducted in an outdoor environmental. Each dog was observed in executing five words of commands commonly used to control the K-9s in a working scenario. These words were: heel; sit; stay; recall and find. The EDDs responses to each words of command were observed, and time taken noted. Each correct response was awarded a score of one (1) while wrong response was not awarded a score (0). A limit of 60 seconds was allowed in demonstrating the five words of command.

The EDD behavioural responses in detecting concealed explosives assessment.

The experiment was conducted in an outdoor environmental setting. Three boxes without explosives were placed along a line in a spacing of 1 Metre apart. Each dog was observed clearing the boxes for suspected explosives. Five behavioural responses demonstrated by the EDD in detecting explosives and used to alert the dog handlers were used in assessing the EDDs responses. The five pre-determined behavioural responses were change of dogs' tail carriage, increased cadence, change of nose height, sniffing and response to words of commands. Correct responses were awarded a score of one (1), while incorrect responses were not awarded a score. Time taken in clearing the three boxes was also noted. A limit of 240 seconds was set in this stage.

The EDD behavioural responses in locating concealed explosives assessment.

The exercise was conducted in an outdoor setting environment. Three boxes stashed with items of clothing in a spacing of 1 metre apart in line were used. Each box measured 90 cm x 60 cm. A stick of trinitrotoluene (TNT) measuring 8 centimetres was concealed in the middle box and each dog was observed while clearing each box. The five pre-determined responses observed and noted were: reduced cadence; heightened sniffing; halting; a gaze and a bold indication in locating explosives demonstrated by: barking; halting; freezing; squatting or sitting. Each correct response was noted as 'Yes' and awarded a score of one (1) while wrong responses were noted as 'No' and awarded no score. A maximum 240 seconds set in this stage.

The EDDs experience assessment

Three boxes in a cluster were placed at the four corners of an open field measuring 10 metres squares and the fifth cluster was placed in the middle of the field. One box in each cluster was randomly selected and genuine explosive substance concealed inside. The five genuine explosives used were concealed in each box. The explosives concealed inside the five boxes were: composite four explosives (C-4); detonator cord; detonator; TNT and safety fuse. Time taken by each dog to recognize the presence of each explosive in the five boxes was noted. The recognition of each explosive in the box was noted as 'Yes' and awarded a score of one (1). Each dog that failed to recognize each explosive in the box was not awarded a score. A time limit of 240 seconds was allowed in this stage.

Data *Collection and Analysis*

The data for each quasi – experiment was logged in an observation checklist and summarized in descriptive statistics in establishing the EDDs mean performance for each variable. Pearson's

correlation coefficient was used to measure the variables correlation against time taken while linear regression model was employed to determine the variables' coefficient.

Results

The results for this study are organized in sections and in a style following the manner the variables and their attributes were studied:

The EDDs words of commands assessment

Each EDDs was observed in executing five words of commands issued by the dog handler in a quasi – experimental settings. The five words of command were: heel; sit; stay; come and find. A time of sixty seconds was the time limit set in this exercise. The sample mean performance for each word of command was calculated and the results shown in table one below. The table also shows the results of the correlation and coefficient of the assessed variables by use of Pearson' coefficient of correlation and the variables coefficient.

Table 1: The EDDs mean performance, standard deviation, variance, and bivariate coefficient

Attributes	Heel	Sit	Stay	Come/Recall	Find	Mean sample performance	Mean time taken (s)
Mean performance	1.00	1.00	.70	.80	.70	.84	40
Pearson correlation		- .934 Sig .000					
Bivariate coefficient		Adjusted R = .857					

Interpretations

The mean attributes performance ranged between 1.00 and .70 and a mean of .84 was established in calculating the EDDs words of commands performance. A mean performance of 1.00 for the words of command; heel and stay shows that all the dogs executed the two words of command. A mean performance of .80 and .70 noted for the attributes; recall and find indicates that two dogs and three dogs respectively did not execute these words of command. A mean of .84 indicated in table one above shows that the EDDs could execute the five words of commands with a proficiency level of 84% with a mean of 40 seconds as the time taken to demonstrate the performance for the five words of command by the sample. A strong significant negative correlation established (r = - .934, sig .000) in the K-9s knowledge performance against time taken showed that the relationship between the EDDs ability to execute the five words of commands and time taken in a working scenario are negatively related, with higher levels of executing the words commands being associated with little in demonstrating the commands. This model was established to be

suitable in predicting the performance of the EDDs population by 85.7 % (R =.857). The 23.7 % errors in this model were associated with other variables not considered in this study.

The `EDDs behavioral responses in detecting concealed explosives assessment.

Five attributes for this variable were observed and their mean calculated. A time limit of 240 seconds was set for this assessment. Pearson's correlation model was used in measuring the EDDs responses against time in demonstrating the five attributes while bivariate linear regression model was used in calculating the coefficient of their behavioral responses against time taken in screening for the concealed explosives. The results of this study are shown in table 2 below.

Table 2: The responses made by the EDDs while detecting for concealed explosives, the variables correlations and coefficient.

Attribute	Change of tail carriage	Increased cadence	Sniffing	Change of nose height	Obedient to five words of commands	Mean attributes assessment	Time taken. (Secs)
Mean	1.00	.90	.90	1.00	.70	.90	136.0
Pearson's correlation (time taken against responses)	- .638 Sig .047						
Bivariate coefficient (Responses against time taken	R = .333						

Interpretations

The mean performance for the attributes ranged from 1.00 to .70. A mean performance of 1.00 obtained for the two attributes: change of tail carriage and change of nose height indicated that all EDDs demonstrated these two responses.

A mean performance of .90 for the increased cadence and sniffing meant that one each dog did not demonstrate these responses. and A mean of .70 indicated that three dogs did not demonstrate three behavioral responses as required when commanded to search. Overall, the mean performance in demonstrating the behavioral responses was established to be .90 (90 %). A significant negative correlation established (r = - .638, sig .047) was established between the EDDs responses against time. This observation implies that a negative correlation exists between the EDDs responses in detecting concealed explosives and time taken in a working scenario, with higher levels of responses in detecting explosives being associated with little time in their performance. This model established that the results of this study can be used in predicting the performance of the EDDs by

an accuracy of 33.3 .7 % (R =.333). The 23.7 % error in this model were associated with other variables not considered in this study.

The EDDs responses assessment in locating explosives.

Each dog was observed while screening three boxes measuring 90 cm X 60 cm with a spacing of 1 meter in a line. A stick of TNT was concealed in the middle box. Their behavioral responses were observed while locating the concealed TNT. Five pre-determined responses usually demonstrated by the EDDs in a working scenario were used as baseline for this study. The five responses were: reduced cadence; heightened sniffing; halting; a gaze and indication by: barking; halting; freezing; squatting or sitting. The results of this study are shown in table 3 below.

Table 3: The performance of the K-9s in locating explosives.

Attributes	Reduced cadence	Heightened sniffing	Pausing	Fixed gesture	Final indication responses	Mean attributes performance	Time taken
Mean performance	.80	.80	.80	.70	.90	.80	137.5
Pearson's correlation	.571 Sig .084						

Interpretations

The mean performance ranging from .80 to .70 summarizes the sample performance. A mean performance of .90, .80 .70, indicated in each attribute showed that three dogs did not demonstrate the attribute 'fixed gesture' (mean performance = .70); two dogs did not demonstrate the attributes : reduced cadence and pausing (mean performance = .80); while one dog did not demonstrate the final bold indication in locating explosives. An in significant positive correlation was established between the skills in locating explosives against time taken in locating for explosives. (r = .571, sig .084). This demonstrated that the K-9s skills in locating explosives against time taken had a positive relationship in a working scenario, higher values of skills in detecting explosives being associated with more time taken in locating explosives. This observation contradicted the anticipated theory of the EDDs performance in a working scenario. This anomaly was associated with other variables not included in this study and noted to have a significant role in determining the K-9s performance.

The EDDs experience assessment in screening for five samples of concealed explosives

Five boxes each having an explosive substance concealed inside were placed at a corner amongst a cluster of two other boxes in open field measuring 10 meters square. The fifth cluster of two boxes and one box with concealed explosive inside were placed in the middle of the field. A time limit of 240 seconds was observed in this stage. Each K-9 was observed in demonstrating their experience in identifying the five different explosives concealed explosives concealed inside the

boxes. The explosives that were concealed in the five boxes were: C-4; detonator cord; detonator; TNT and safety fuse. Time taken in identifying these concealed explosives noted. The results for their performance are tabulated in table 4 below:

Table 4: The K-9s experience in identifying concealed explosives; their correlation and coefficient.

Attributes	C-4	Detonator cord	Detonator	TNT	Safety Fuze	Mean attributes performance	Time taken
Mean	.50	.80	.70	.60	.70	.66	200.9
Pearson's Correlations	-.739; Sig .013						
Bivariate Coefficient	Adjusted R= .506 Beta = - .749						

Interpretations

The attribute mean performance of .50, .60, .70 and .80 shows that five, four, three and two dogs did not make a positive indication for the presence of: C -4, TNT, detonator, safety fuze and detonator cord in that order, respectively. A significant strong negative correlation established (r = - .739 , sig .013) for the K-9s experience against time taken in identifying explosives shows that the relationship between these two variables had an inverse relation, with higher values of K-9s experience associated with little time taken by the K-9s in identifying specific explosives in a working scenario. This model established that an inference of 50.6% can be made in predicting the EDDs sample performance to the population. The 49.4 % error in this model for predicting the sample performance to the population was attributed to other variables not considered in this study.

Discussions

This study assessed the EDDs performance in screening for concealed explosives by an observation method in a quasi – experimental settings. Five variables were observed in determining the EDDs performance. This study observed that the process of screening for concealed explosives is a 'praxis' that utilizes the five components observed cumulatively and in a random manner. Each component augments the outcome of each other in an autopoietic manner. The findings for this study established that the sample of the EDDs observed adequately possessed the following potentials in their working scenario; employment of knowledge in their working scenario: knowledge in screening for explosives, 84%; skills in detecting explosives, 90%; skills in locating explosives, 80% and their experience in identifying concealed explosives, 66%.

The EDDs responses to words of commands assessment

This assessment involved observing the dogs while executing five pre-determined words used in controlling the dogs in a working scenario: heel; sit; stay; recall and find. A variation in their mean performance by each dog was noted in their performance. Examination of their variations in

responses was noted to emerge from: the dog breed characteristics, the dog gender, the handler's relationship with the dogs, the time of the day and the places where the experiment was conducted. However, a general pattern in responses to the words of commands emerged from this study: a perfect significant negative relationship for the EDDs responses to the words of commands and time taken in responding to words of commands (- .934, sig .000).

This study established that quick performance in responses to words of command was associated with shorter time taken by the EDDs. However, other variables emerged during the study that significantly influenced the performance of the EDDs in executing the five words of commands. These emergent variables that occasioned the variations of the EDDs performance in this study were: the dog handlers cue in issuing the words of commands, the presence of other dogs within the vicinity, the dog breeds and the dogs' gender. These emergent variables were not considered in this study and were attributed to variations in the EDDs performance in executing the five words of commands. However, the outcome of this study reliability is uncertain due to the sample size investigated (n = 10). Studies have also indicated that there exist vulnerabilities in training the EDDs in screening for concealed explosives in a working scenario (Furton, 2010; Concha etal, 2014). According to Furton (2010), this field lacks peer reviewed research on the praxis error rates and best practices for assessing their performance in a working scenario.

The *EDDs assessment in their behavioral responses in detecting for concealed explosives.*

This study observed the behavioral response made by the dogs in a working scenario by using five pre -determined responses as the baseline for observations. The behavioral responses assessed were change of tail carriage, increased cadence, sniffing, change of nose height and obedience to words of command in a working scenario. The data in table 2 shows a variation for the sample performance in demonstrating alert indications associated with the EDDs performance while detecting for concealed explosives in a working scenario.

The behavioral responses observed in the study were: change of tail carriage, increased cadence, sniffing, change of nose height and responses to word of command search. This study noted that all EDDs (n = 10) were able to demonstrate responses in change of tail carriage, and change of nose height, 9 dogs demonstrated increased cadence, nine dogs demonstrated sniffing behavior and seven dogs were able to respond appropriately to the word of command search. The variations emanated to differences in dogs breeds, age, sex, and dog handler's management of the dog in a working scenario. The male dog was also noted to be aggressive in presence of female dogs' in estrus cycle (Blendinger,2016; Blendinger, 2007). The male dogs diverted their attention into seeking the female dog more aggressively than females' dogs (Scandura, et al, 2018).

The EDDs were also noted to demonstrate episodes of panting in a working scenario. Gazit (2003) noted that the endurance of the dogs in screening for explosive is limited since they cannot sniff and pant at the same time. The observations by Gazit (2003) and Concha et. al (2014) could be used to explain the variations observed in this study while assessing the performance of the K-9s in screening for explosive substances. The intermittent changes of dogs' nose carriage in detecting and locating the concealed explosives was occasioned by variations of scent trail and dispersal

(Christensen, 2016). These emergent behavioral responses were excluded in this study and their influence for the K-9s in a working scenario was excluded in this study.

The EDDs behavioral responses in locating concealed explosives.

This study observed five attributes associated with responses made by the EDDs when they locate concealed explosives in a working scenario. The five parameters observed were: reduced cadence, heightened sniffing, reduced cadence, fixed gaze at the explosive location and demonstrating the final alert indication by barking, freezing, or sitting down. This study established a mean performance for the EDDs in locating explosives to be .80 (80 %). The variations were observed to be emanating from their ability to demonstrate behavioral indications when the EDDs locate concealed explosives. During their performance in locating concealed explosives, the sample demonstrated their alert indications as follows: reduced cadence, 8 dogs; heightened sniffing, 8 dogs; halting, 8 dogs; fixed staring, 7 dogs and making final alert indication, 9 dogs as demonstrated in table 3 above. This variation was observed to have an inconsistent pattern and difficult to indicate the source of this variation in cognizant with the variables studied.

The EDDs responses in their use of experience in identifying a sample of five explosives.

The EDDs were assessed in their ability to identifying the presence of five samples of concealed explosive substances. These substances were: C-4; detonator cord, a detonator, TNT, and safety fuze. The results in table four shows that the mean performance of the EDDs in screening for the sample of five explosives was calculated to be .60 (60 %) in a working scenario. Their mean attributes in their experience associated with the ability to identify each sampled explosive was: C -4, .50; detonator cord, .80; detonator, .70; TNT,.60 and safety fuze, .70. This observation was associated with varying exposure to the EDDs to in identifying a range of explosives a working scenario.

The assessment of time taken by the EDDs in demonstrating their responses.

This study noted that the EDDs are specifically trained to screen for explosives in a working scenario. However, this study established that their performance in acquiring knowledge to respond to words of commands, skills in detecting explosives, skills in locating explosives and their experience differ as demonstrated by different times demonstrated by each EDDs in their performance. However, this study established an inverse relation with the EDDs performance in employing their knowledge, skills in detecting explosives, skills in locating concealed explosives and use of their experience in a working scenario.

Summary of Findings

This study assessed the performance of the K-9s in a working scenario through an empirical method. An observation method in a quasi-experimental setting was used to study five variables for this study. This study noted a variation in the performance for the variables studied as demonstrated by varied mean, standard deviations, correlations, and coefficient as indicated in tables: in tables 1; 2; 3;3 and 4. Analysis of the K-9s performance in a working scenario showed that knowledge in all the K-9s performance for screening explosives has a significant influence in

their performance. This knowledge was noted to be embedded into the K-9s cognition during training and utilized in a working scenario. A strong negative correlation was subsequently established between the K-9s knowledge and time taken in a working scenario; the high levels of knowledge endowment for the K-9s being associated with little time taken by the K-9s in screening for concealed explosives.

Managerial Implications

This study is expected to contribute three components into the field of the K-9s in a working scenario: the knowledge and skills utilized by the K-9s at tactical levels; the employment of the K-9s at the operational level and decisions pertaining to the use of K-9s in security operations at strategic level. At the tactical level, this study can be used as a baseline standard for assessing the K-9s performance in a working scenario noting that there were other variables not included in this study. This model is easier to replicate and use at tactical level. At the operational level, this study can be used in harmonizing the K-9s training and at the strategic level, this study findings can be used at making decisions on the K-9s employment in screening for concealed explosives.

Limitations and Directions for Future Research

This study employed a relatively few samples in assessing the performance of the K-9s in a working scenario. The variables were also limited to five components. The study settings were limited to outdoor settings and the findings may not apply in other environmental settings. Other studies can be initiated to investigate the performance of the K-9s in other environmental settings and taking into cognizant other variables that were excluded in this study.

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