

Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

THE USE OF DOGS TO DETECT CARPET BEETLES (*Anthrenocerus australis*)

A thesis presented in partial fulfilment of the requirements
for the degree of Master of Science in Animal Science at
Massey University, Palmerston North, New Zealand

Chloe Phoon Koh Ee

2015

Abstract

This study examined the ability of domestic dogs (*Canis familiaris*) to detect the scent of carpet beetle larvae (*Anthrenocerus australis*). These insects were introduced to New Zealand and are now a pest of woollen carpets and fabrics in this country. The use of detector dogs can help with earlier discovery and identification of infested areas and thus reduce the use of pesticides.

Sixteen harrier hounds were available for this study, however only six dogs were selected for the actual trials after initial training. There were four trials, in which the dogs had to detect four different stimuli (dog food A, carpet beetle larvae, cockroaches and dog food B). Each run evaluated whether the dog could identify the target pottle out of six pottles. The other five pottles were empty. A dog completed six runs each day over five days for food A and over three days for the other three stimuli. Therefore there were a total of 30 runs for food A and 18 runs for the rest of the stimuli. A run was considered successful when the dog found the target pottle on the first try (i.e. first pass around the circle) without any false positives (sitting at a pottle that did not contain the stimulus).

The dogs were able to identify dog food A and B with an average success of 74.5% and 78.9% respectively. The detection rate for dog food was significantly higher than would be expected if the dogs were selecting pottles at random ($z \geq 1.64$, $p < 0.05$). However they were unable to identify either the carpet beetle larvae or cockroaches, with an average success of only 27.7% and 45.5% respectively. These results indicate that the dogs were incapable of detecting carpet beetle larvae. This could be due to several reasons such as dog breed, learning inflexibility, handler influences and methodology. The dogs used may have not been the best choice for this experiment, however they were chosen based on availability. The dogs were trained first on food before the insect trials, hence they may not have been able to create a new association between the reinforcer and insect stimuli. The handler and her techniques may have influenced the dogs to select the target pottle unintentionally (e.g. longer pauses at the target pottle) as there was a higher success rate for formal tests compared to blind tests (in which the handler did not know where the target pottle was) ($Z = -3.5$, $p = 0.0005$).

Future studies could look at the ability of other dog breeds to detect carpet beetles. More research should be done on the effects of temperament in scent detection dogs. Future research could investigate if detector dogs can differentiate between different carpet beetle species and if they are able to detect carpet beetles in the field (i.e. in museums or houses).

Contents

Title Page	1
Abstract	2
Contents	4
List of Figures	7
List of Tables	8
Chapter 1 Introduction	
1.1 Biosecurity	11
1.2 Dogs used to Detect Insects	13
1.3 Dermestid Beetles	14
1.4 Thesis Structure	16
Chapter 2 Literature Review	
2.1 Introduction.....	19
2.2 Domestication	19
2.3 Temperament and Personality	20
2.3.1 Definition	20
2.3.2 Genetics and temperament	20
2.3.3 Methods for assessing temperament	22
2.3.4 Temperament in working dogs	24
2.3.5 Other	24
2.4 Anatomy and Physiology	25
2.4.1 Anatomy of dog's nose	25
2.4.2 Sniffing	25
2.4.3 Odorant receptors	26
2.5 Temperament and Personality	26
2.5.1 Habituation	27
2.5.2 Imprinting	27
2.5.3 Insight learning	28
2.5.4 Observational learning.....	28

2.5.5 Classical conditioning.....	29
2.5.6 Operant conditioning.....	30
2.5.7 Reinforcement and Punishment	31
2.6 Training a Dog	35
2.6.1 Basic obedience and training	36
2.6.2 Detection training	36

Chapter 3 Methods

3.1 Dogs.....	41
3.2 Location and Facilities	41
3.3 Training Procedures	43
3.3.1 Bonding	43
3.3.2 Teaching the “Sit” command	45
3.3.3 Equipment for the scent training	49
3.3.4 Training in the experimental model	52
3.4 Experimental Trials	58
3.4.1 Formal tests	58
3.4.2 Blind tests	60
3.4.3 Statistical Analysis	61

Chapter 4 Results

4.1 Trial 1 – Dog Food A	64
4.2 Trial 2 – Beetle Larvae	65
4.3 Trial 3 – Cockroach	66
4.4 Trial 4 – Dog Food B	66
4.5 Differences in Trials and Dogs	67
4.6 Dog Behaviour during Scent Trials	69

Chapter 5 Discussion

5.1 The Dogs	71
5.1.1 Dog Breed	71
5.1.2 Learning inflexibility	73
5.1.3 Temperament and motivation	74
5.2 Limitations in Methodology	75
5.2.1 Dog Selection	75

5.2.2 Equipment	76
5.2.3 Stimuli: Dog food, beetle larvae & cockroach	76
5.2.4 Time	77
5.2.5 Training methods	77
5.2.6 Trial design	78
5.3 Handler Influences	79
5.4 Uncontrolled Variables	80
5.5 Future Recommendations	80
5.5.1 The dogs	80
5.5.2 Training	82
5.5.3 Trial design	83
5.5.4 Conclusions	84
 References	 85
 Appendix for Raw Data	 109

List of Figures

Figure 1.1 Carpet that has been attacked by carpet beetles	15
Figure 2.1 Classical (Pavlovian) conditioning	30
Figure 3.1 Outdoor facility where bonding and sit training was done	42
Figure 3.2 Indoor facility where training and experiments were done	42
Figure 3.3 Teaching Golly the sit command by holding the treat over the dog's head	46
Figure 3.4 Giving her a treat after she performs the task	46
Figure 3.5 Example of plastic pottle used in training and experiment	50
Figure 3.6 Example of wooden block used in training and experiment	50
Figure 3.7 Diagram of the whole room (testing and waiting room)	53
Figure 3.8 Picture of the room with the waiting room door open	53
Figure 3.9 Picture of how the blocks were arranged experiments	55
Figure 3.10 Bella being led around the circle of blocks and encouraged to smell each pottle	55
Figure 3.11 Beetle larvae placed in the target pottle	57
Figure 3.12 An American cockroach in the target pottle	57

List of Tables

Table 3.1 Characteristics of Harrier Hounds used in this study. Observations of their behaviour and temperament after two weeks.	44
Table 3.2 Response of each dog after the first few days of teaching the "sit" command	47
Table 3.3 Progress after teaching them the "sit" command after two weeks	48
Table 3.4 The schedule for all training and trials that were run for this study. The dogs were trained in between trials.	52
Table 3.5 The criterion for a success for a dog in each trial. A binomial test was used to calculate the number of correct trials required to be significantly different from chance and therefore considered a success.	62
Table 4.1 Results for food stimulus. This table shows how many successful runs each dog completed in each trial. Each trial was 6 runs and there were 5 trials, therefore there were a total of 30 runs. The results were calculated as the percent correct. A dog was considered successful if it identified the correct pottle 20 times or more out of 30 runs (Table 3.5). False positives were classified as a fail.	64
Table 4.2 Results for carpet beetle larvae. This table shows how many successful runs each dog completed in each trial. Each trial was 6 runs and there were 3 trials (two formal and one blind), therefore there were a total of 18 runs. The results were calculated as the percent correct. A dog was considered successful if it identified the correct pottle 13 times or more (see Table 3.5). False positives were classified as a fail.	65
Table 4.3 Results for cockroach. This table shows how many successful runs each dog completed in each trial. Each trial was 6 runs and there were 3 trials (two formal and one blind), therefore there were a total of 18 runs. The results were calculated as the percent correct. A dog was considered successful if it identified the correct pottle 13 times or more (see Table 3.5). False positives were classified as a fail.	66

Table 4.4 Results for food B. This table shows how many successful runs each dog completed in each trial. Each trial was 6 runs and there were 3 trials (two formal and one blind), therefore there were a total of 18 runs. The results were calculated as the percent correct. A dog was considered successful if it identified the correct pottle 13 times or more (see Table 3.5). False positives were classified as a fail.	67
Table 4.5 Predicted probability of detection, and 95% Confidence Interval (CI), by stimulus and test type. Values obtained from a logistic regression model that used General Estimating Equations to account for repeat measures within dogs and multiple tests on the same day. Chorus's results were not included, so n=5 dogs.	68
Table 5.1 The ability of dogs to detect pest insects or substances infected with pest insects.	72
Table 6.1 The target pottle contained a few carpet beetle larvae. 1 indicates a successful scent exercise, 0 indicates a failed scent exercise. 1* indicated one false positive before finding the target pottle, this was also classified as a fail.	110
Table 6.2 The target pottle contained one cockroach. 1 indicates a successful scent exercise, 0 indicates a failed scent exercise. 1* indicated one false positive before finding the target pottle, this was also classified as a fail.	111
Table 6.3 The target pottle contained dog food B. 1 indicates a successful scent exercise, 0 indicates a failed scent exercise. 1* indicated one false positive before finding the target pottle, this was also classified as a fail.	112