

Effect of breed on thermal pain sensitivity in dogs

A thesis presented in partial fulfilment of the requirements for the degree of

Master of Science

in

Zoology

at Massey University, Manawatū,
New Zealand

James Bowden

2016

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.

Abstract

A problem in assessing pain sensitivity in animals is the variability among individuals within a species. Thermal nociceptive threshold (TNT) testing is used to measure pain sensitivity in animals. However, little research has been done on within species differences in pain sensitivity, with most studies focusing on the effectiveness of analgesics. This research was carried out to see if there was any variation in baseline TNTs in different dog breeds.

To determine TNTs, a heat stimulus was applied to the leg of a dog using a new device that could be remotely activated. This removed the need to restrain the dogs. The time and temperature at which the dog responded behaviourally was recorded. The TNT of dog was recorded six times in a one-hour session, once a week, for four consecutive weeks.

In the first experiment the repeatability of harrier hound (n= 11) TNTs over time and the effects of the initial thermode temperature were examined. The results indicated that TNTs were repeatable over the daily test, session however they were affected by week of testing, thermode and initial thermode temperature. It was concluded that using a consistent elevated initial thermode temperature was more consistent than the natural starting temperature.

The aim of the second experiment was to investigate differences in TNTs between three dog breeds: harrier hounds, greyhounds, and huntaways (n=10 per breed). A breed effect was found whereby huntaways took significantly longer to respond than harrier hounds and responded at higher temperatures than greyhounds and harrier hounds. There were no differences between greyhounds and harrier hounds. This study provides the first scientific evidence of breed differences in pain sensitivity in dogs.

It is concluded that there were differences in thermal pain thresholds between the three dog breeds tested. The study supported the use of TNT testing on dogs and offered new insight into ways to improve the reliability of threshold testing. Future work should use more breeds, evaluate pain sensitivity in other modalities, and assess the effect of analgesics on TNTs in dogs.

Acknowledgements

Thanks firstly to my supervisors, Professor Kevin Stafford and Dr Ngaio Beausoleil.

Thank you to Mike Giesege for trusting me in operating his new thermal threshold device. Your support and cooperation helped make this research possible.

Thanks for Rao Dukupati for your help in statistical analysis.

A huge thank you to everyone that let me use their dogs and helped transport them to Massey University. These include: Karin Weidgraaf, Jolene MacFarlane, Neil and Sandy Marshall, Jocelyn and the team at Estendart, and Sarah.

Finally thanks to my friends and loved ones that helped me get through this.

Contents

Abstract	2
Acknowledgements	3
Contents.....	4
List of figures and tables	9
1. Literature Review.....	11
1.2 Pain in Mammals	13
1.2.1 Defining Pain	13
1.2.2 Nociceptors.....	14
1.2.3 Pain Pathway.....	15
1.2.3.1 Signal Transduction.....	15
1.2.3.2 Signal Transmission	15
1.2.3.3 Pathways in the brain	16
1.2.3.4 Descending pain pathway	17
1.2.4 Types of Pain.....	17
1.2.4.1 Acute pain	17
1.2.4.2 Chronic pain	18
1.2.4.3 Pain Sensitisation.....	18
1.2.4.4 Visceral Pain.....	19
1.3 Assessing pain in dogs	19
1.3.1 Behaviour-based pain assessment in dogs	19
1.3.1.1 Pain scales	20
1.3.1.2 Challenges in using behaviour for assessment of pain.....	21
1.3.2 Physiological measures of pain	22
1.3.3 Nociceptive Threshold testing (Quantitative Sensory testing).....	23
1.3.3.1 Electrical NTT	24
1.3.3.2 Mechanical NTT	25

1.3.3.3 Thermal NTT	26
1.3.3.3.1 Ambient temperature	26
1.3.3.3.2 Remote thermal NTT	27
1.3.3.3.3 Direct thermal NTT using thermodes.....	28
1.4 NTT differences within mammalian species	29
1.5 Physiological differences between dog breeds	29
1.6 Conclusions	30
2. Repeatability of thermal nociceptive thresholds measured with a new remotely activated device and the effect of initial thermode temperature on thermal thresholds of harrier hounds	31
2.1 Introduction	32
2.2 Materials and Methods	33
2.2.1 Animal Ethics Approval	33
2.2.2 Animals and facilities	33
2.2.3 Habituation.....	34
2.2.4 Experimental design	35
2.2.5 Thermal nociceptive threshold testing device	36
2.2.5.1 Thermode	36
2.2.5.2 Controller	36
2.2.5.3 Power supply	37
2.2.5.4 Harness	37
2.2.5.5 Software	37
2.2.5.6 Commands	38
2.2.6 Experimental procedure.....	39
2.2.7 Statistical analysis	40
2.3 Results	41
2.3.1 Latency to Respond.....	41
2.3.2 Response temperature	43

2.3.3 Initial thermode temperature	44
2.4 Discussion.....	46
2.4.1 Repeatability	46
2.4.1.1 Test	46
2.4.1.2 Week	47
2.4.2 The variation between the two testing conditions	48
2.4.3 Differences between latency and response	49
2.4.4 Ambient temperature	49
2.4.5 Limitations.....	50
2.4.5.1 Thermodes	50
2.4.5.2 Stress	51
2.4.5.3 Order effect	51
2.4.5.4 Study animals	51
2.5 Conclusions	52
3. Breed differences in pain sensitivity in dogs	53
3.1 Introduction	54
3.2 Materials and Methods.....	55
3.2.1 Animal Ethics Approval	55
3.2.2 Animals and experimental conditions	56
3.2.2.1 Habituation	56
3.2.3 Experimental design	57
3.2.4 Thermal nociceptive threshold testing device	57
3.2.5 Experimental procedure.....	59
3.2.6 Statistical analysis	60
3.3 Results	61
3.3.1 Latency to Respond.....	61
3.3.2 Response temperature	62

3.3.3 Analysis with first test removed.....	64
3.4 Discussion.....	66
3.4.1 Possible reasons for breed difference	66
3.4.1.1 Physiological difference between dog breeds	66
3.4.1.2 Environment	67
3.4.1.3 Stress-Induced analgesia	68
3.4.2 Repeatability	69
3.4.2.1 Test effect.....	69
3.4.2.2 Week effect	69
3.4.2.3 Initial thermode temperature.....	69
3.4.2.4 Thermodes	69
3.4.3 Behavioural responses	70
3.4.4 Differences between response variables	70
3.4.5 Limitations.....	71
3.4.5.1 Device	71
3.4.5.2 Burning	71
3.4.5.3 Initial Temperature of the thermode.....	71
3.4.5.4 Stress	72
3.4.5.5 Study Animals.....	72
3.5 Conclusions	72
4. General Discussion	74
4.1 Overview of results	74
4.2 Method considerations	74
4.2.1 Thermodes.....	74
4.2.2 Study Animals.....	75
4.2.3 Behaviour Responses.....	75
4.2.4 Repeatability of results over time.....	76

4.2.5 Differences between initial thermode conditions.....	76
4.2.6 Differences between response temperature and latency to respond	77
4.3 Future research.....	77
4.3.1 Dogs	77
4.3.2 Behaviour.....	77
4.3.3 Analgesics	78
4.4 Summary.....	78
5. References.....	79

List of figures and tables

Figures

Figure 2.1: The thermal nociceptive threshold device, showing the custom made controller and thermode.	38
Figure 2.2: The thermal nociceptive threshold device, showing the dog harness with the controller attached.....	39
Figure 2.3: Differences in raw mean \pm SE between the weeks for latency to respond (seconds) with both normal and elevated baseline conditions. Significant differences between weeks within the normal condition are indicated by the different letters. Significant differences between conditions within week are indicated by asterisk. Differences considered significant at $p < 0.05$	43
Figure 2.4: Differences in raw mean \pm SE between the weeks for response temperature ($^{\circ}\text{C}$) with both normal and elevated baseline conditions. Significant differences between weeks within the normal condition are indicated by the different letters a and b. Significant differences between weeks within the elevated condition are indicated by the different letters c and d. Significant differences between conditions within week are indicated by asterisk. Differences considered significant at $p < 0.05$	44
Figure 2.5: Differences in raw mean \pm SE between the weeks for initial thermode temperature ($^{\circ}\text{C}$) with both normal and elevated baseline conditions. Significant differences between weeks within the normal condition are indicated by the different letters. Significant differences between conditions within week are indicated by asterisk. Differences considered significant at $p < 0.05$	45
Figure 2.6: Differences in raw mean \pm SE between the tests for initial thermode temperature ($^{\circ}\text{C}$) with both normal and elevated baseline conditions. Significant differences between tests within the normal condition are indicated by the different letters. Significant differences between conditions within tests are indicated by asterisk. Differences considered significant at $p < 0.05$	45
Figure 3.2: Test effect on latency to respond (seconds) (raw mean \pm SE). Significant differences are indicated by different letters. Differences considered significant at $p < 0.05$	62

Figure 3.3: Test effect on response temperature (°C) (raw mean ± SE). Significant differences are indicated by different letters. Differences considered significant at $p < 0.05$ 64

Figure 3.4: Raw mean ± SE for the breeds for latency to respond (seconds), after the 1st test has been removed. Significant differences between breeds are indicated by the different letters. Differences considered significant at $p < 0.05$ 65

Figure 3.5: Raw mean ± SE for the breeds for response temperature (°C), after the first test has been removed. Significant differences between breeds are indicated by the different letters. Differences considered significant at $p < 0.05$ 65

Tables

Table 2.1: Dogs used in the first study. 34

Table 2.2: Results of statistical analysis for latency to respond (seconds), response temperature (°C), and initial thermode temperature (°C) using raw data. 42

Table 3.1: Dogs used in the study, their breed, sex, age, source and the distance travelled each session between source and Massey University 58

Table 3.2: Results of statistical analysis for latency to respond (seconds) and response temperature (°C), using Bloms transformed data. 63

Table 3.3: Results of statistical analysis for latency to respond (seconds) and response temperature (°C), using Bloms transformed data after the first test has been removed. Only significant interactions between variables at $p < 0.05$ for are shown. 63