



MONASH University

An examination of attitudes and kennel management practices relating to the welfare of working dogs

By Mia Louise Cobb

BSc (Hons)

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School of Psychological Sciences

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Abstract

Animal welfare is of growing importance to industries reliant upon animals, such as the diverse working dog industry. Working dogs play many important roles in contemporary societies, including assistance, detection, herding and guard roles, and racing and performance industries. Successful management of their welfare is critical for both ethical and economic reasons. In the context of changing societal awareness and perceptions of animal welfare, this thesis critically reviews existing literature on the 'production' of working dogs, then introduces the concept of canine performance science as a way for the working dog industry to meet modern expectations. A voluntary, internet-based survey was conducted to understand public perceptions of the welfare status of working dogs and how it may vary with context, and attitudes about the management practices of dogs housed in kennel facilities.

As a specific example of one aspect of working dog welfare, industry conditions for young working dogs entering a kennel facility were investigated via physiological measurements. Young working dogs showed evidence of physiological stress when transferring from the puppy raising home to kennel facility environments. Further investigation in this setting explored whether a composite enrichment program could help to reduce stress in dogs transitioning into kennels, with findings showing enrichment did not increase stress and may help dogs complete their training. The results highlighted the complexities of studying stress responses in dogs, with no simple relationship between physiology, welfare, and performance evident. A systematic review and meta-analysis of existing canine stress response studies follow, focussed on salivary cortisol, which is widely used but poorly understood. Again, the intra- and inter-individual variability in findings suggests a careful approach is required when interpreting existing studies and conducting future studies.

The complex and multi-dimensional nature of public perception toward working dog welfare was explored using multiple approaches. Future models for measuring animal welfare should include the critical dimension of human-animal interaction. Impact of stress responses on the readiness of young working dogs for training needs further investigation, but a focus on working dogs as individuals is needed to optimise welfare objectives and performance outcomes. Continued research into the welfare of working dogs will help align industry practices with wider societal standards.

Research activity during candidature

PUBLISHED MANUSCRIPTS

Cobb ML, Iskandarani K, Chinchilli VM, Dreschel NA. (2016) A systematic review and meta-analysis of salivary cortisol measurement in domestic canines. *Domestic Animal Endocrinology* 57:31-42.

Cobb M, Branson N, McGreevy P, Lill A, & Bennett P. (2015) The advent of canine performance science: offering a sustainable future for working dogs. *Behavioural processes* 110: 96-104.

MANUSCRIPTS ACCEPTED

Cobb ML, Lill A, Bennett PC. Not all dogs are equal: Perception of canine welfare varies with context. Accepted for publication, July 2019: *Animal Welfare*.

MANUSCRIPTS SUBMITTED

Cobb ML, Carter A, Lill A, Bennett PC. Perceived importance of specific kennel management practices for the provision of canine welfare. Submitted, July 2019: *Applied Animal Behaviour Science*.

Cobb ML, Carter A, Lill A, Bennett PC. Physiological responses of young working dogs entering training kennels from puppy raising homes: a pilot study. Submitted, July 2019: *Physiology & Behavior*.

Cobb ML, Carter A, Lill A, Bennett PC. The effect of a composite enrichment program on the stress physiology and performance of young working dogs housed in a kennel facility. Submitted, July 2019: *Physiology & Behavior*.

PUBLISHED CONFERENCE ABSTRACTS

Cobb M, Lill A, Bennett P. (2014). Perceived welfare status of domestic dogs. *Journal of Veterinary Behavior: Clinical Applications and Research* 9 (6): e11.

Cobb M, Lill A, Bennett P. (2014) Canine stress physiology and coping styles in kennels. *Journal of Veterinary Behavior: Clinical Applications and Research* 9 (6): e11.

CONFERENCE PRESENTATIONS

INVITED ADDRESSES

Cobb, M. (2016) Doglogbook: helping dogs get the best out of life. RSPCA Australia Animal Welfare Seminar: A Dog's Life – are we treating dogs as our best friends? November 25, Melbourne, Australia.

Cobb, M. (2015) Canine welfare: implications for management and behaviour. Australian Institute of Animal Management. October 15, Townsville, Australia

Cobb M and Branson N. (2015) Review of Best Practice Rearing, Socialisation, Education and Training Methods for Greyhounds in a Racing Context. Greyhound Breeders, Owners, Trainers Association Seminar. August 21, Sydney, Australia

Cobb, M. (2013) Getting to Zero with social media – the science of engagement. G2Z Animal Sheltering Summit 2013: Taking G2Z To The Next Level. September 11-13, Gold Coast, Australia.

Cobb, M. (2013) Working like a dog – affectively. RSPCA Australia Scientific Seminar: When coping is not enough - Promoting positive welfare states in animals. February 26, Canberra, Australia

Cobb, M. (2012) The Australian Working Dog Industry Action Plan. The Australian Animal Welfare Strategy National Workshop. September 11-13, Canberra, Australia

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Cobb M, Lill A, Bennett P (2010) Work, Rest & Play: Understanding our influence on canine welfare to optimise Guide Dog performance. International Guide Dog Federation Seminar. June 25-27, Ottawa, Canada. Plenary presentation.

Cobb M, Lill A, Bennett P. (2009) Enrichment programs and animal welfare: catalyst or catastrophe? 43rd Congress of the International Society for Applied Ethology. Jul 6-10, Cairns, Australia. Oral presentation.

OTHER RESEARCH ACTIVITIES

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Branson N, **Cobb M**, McGreevy P. (2012) Australian Working Dog Industry Action Plan. Australian Government: Department of Agriculture, Fisheries and Forestry.

Branson N, **Cobb M**, McGreevy P. (2010) Australian Working Dog Survey Report 2009. Australian Government: Department of Agriculture, Fisheries and Forestry.

PEER REVIEW AND EDITORIAL ACTIVITY

2015 – present: Frontiers Veterinary Science - Working Dogs: Form and Function (Associate Editor)

2015 – present: PLoS One (Reviewer)

2014 – present: Behavioural Processes (Reviewer)

2010 – 2012: The Australian Veterinary Journal (Reviewer)

TEACHING

2019: Communicating Science Ideas SLE200, Deakin University

2018: Science Communication EES200, Deakin University

2016: Psychology of Human-Animal Relationships PSY3HAR, La Trobe University

2015: Psychology Research Project PSY3RPB, La Trobe University

2015: Social Psychology PSY2SOC, La Trobe University

GUEST LECTURES

University of Melbourne, Australia: 2017/18/19

University of Liverpool, UK: 2016

University of Bristol, UK: 2016

Victoria University, Australia: 2015

ANIMAL ETHICS COMMITTEE

2008-present: Category B (Scientist) member for RSPCA Victoria's Animal Ethics Committee

Thesis including published works declaration

I hereby declare that this thesis contains no material which has been accepted for the award of any other degree or diploma at any university or equivalent institution and that, to the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis. This thesis includes 2 original papers published in peer-reviewed journals, 1 accepted for publication, and 3 submitted publications. The core theme of the thesis is human attitudes and kennel management practices that relate to the welfare of working dogs. The ideas, development and writing up of all the papers in the thesis were the principal responsibility of myself, the student, working within the School of Psychological Sciences under the supervision of Associate Professor Adrian Carter, Associate Professor Alan Lill and Professor Pauleen Bennett. The inclusion of co-authors reflects the fact that the work came from active collaboration between researchers and acknowledges input into team-based research. In the case of Chapters 2, 3, 4, 5, 6 and 7, my contribution to the work involved the following:

Thesis Chapter	Publication Title	Status	Nature and % of student contribution	Co-author name(s) Nature and % of Co-author's contribution*	Co-author(s), Monash student Y/N*
2	The advent of canine performance science: Offering a sustainable future for working dogs	Published	I conducted the literature search, synthesis, prepared the initial draft and edited the final manuscript: 70%	Co-authors were involved in initial discussions to establish the scope of the manuscript and then provided draft feedback to varying extents. Nick Branson: 10% Paul McGreevy: 10% Alan Lill: 5% Pauleen Bennett: 5%	No for all
3	Not all dogs are equal: Perception of canine welfare varies with context.	Accepted	I designed the survey, collected the data and conducted the analysis. I prepared the initial draft and edited the final manuscript: 85%	Co-authors were involved in initial discussions to establish the scope of the study and then provided draft feedback to varying extents. Alan Lill: 5% Pauleen Bennett: 10%	No for all
4	Perceived importance of kennel management practices for the provision of canine welfare.	Submitted	I designed the survey, collected the data and conducted the analysis. I prepared the initial draft and edited the final manuscript: 80%	Co-authors were involved in initial discussions to establish the scope of the study and/or provided draft feedback to varying extents. Alan Lill: 5% Pauleen Bennett: 10% Adrian Carter 5%	No for all
5	Physiological responses of young working dogs entering training kennels from puppy raising homes: a pilot study	Submitted	I designed the study, arranged access to the study population, collected the data and conducted the analysis. I prepared the initial draft and edited the final manuscript: 80%	Co-authors were involved in initial discussions to establish the scope of the study and then provided draft feedback to varying extents. Alan Lill: 5% Pauleen Bennett: 10% Adrian Carter 5%	No for all

Thesis Chapter	Publication Title	Status	Nature and % of student contribution	Co-author name(s) Nature and % of Co-author's contribution*	Co-author(s), Monash student Y/N*
6	The effect of a composite enrichment program on the stress physiology and performance of young working dogs housed in a kennel facility	Submitted	I designed the study, arranged access to the study population, collected the data and conducted the analysis. I prepared the initial draft and edited the final manuscript: 80%	Co-authors were involved in initial discussions to establish the scope of the study and then provided draft feedback to varying extents. Alan Lill: 5% Pauleen Bennett: 10% Adrian Carter 5%	No for all
7	A systematic review and meta-analysis of salivary cortisol measurement in domestic canines	Published	I conceived and designed the study in collaboration. I performed the systematic review, collected the data and prepared it for analysis. I wrote 80% of the initial draft and edited the final manuscript: 55%	Conceived and designed the study. Reviewed systematic review. Collected data and prepared it for analysis. Contributed to all versions of manuscript: Nancy Dreschel: 30% Analysed the data and contributed to final manuscript: Khaled Iskandarani:10% Vernon Chinchilli: 5%	No for all

I have renumbered sections of submitted or published papers in order to generate a consistent presentation within the thesis.

Student name: Mia Cobb

Student signature:

Date: 08 July 2019

I hereby certify that the above declaration correctly reflects the nature and extent of the student's and co-authors' contributions to this work. In instances where I am not the responsible author I have consulted with the responsible author to agree on the respective contributions of the authors.

Main Supervisor name: Adrian Carter

Main Supervisor signature:

Date: 08 July 2019

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Ethical statement

All experimental procedures were approved by animal or human ethics committees at Monash University and performed in accordance with the Australian Code for the responsible conduct of research, the Australian Code of practice for the care and use of animals for scientific purposes and the National statement on ethical conduct in human research.

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Chapter 1

General Introduction

Introduction

Animal welfare is increasingly important to industries that utilise animals, such as the diverse working dog industry [1-3]. This industry encompasses assistance, detection, herding and guard roles, as well as providing entertainment through the racing and performance sectors [4]. Many working dogs are kennelled for months to years during their training and working lives. Kennels are usually designed for easy maintenance of hygiene and to maximise the number of individuals housed, but often fail to meet the behavioural needs of dogs [5]. The stress of living in inadequate kennel facilities can undermine canine wellbeing, learning and performance, and may contribute to dogs failing to achieve operational status [6-9]. In addition to the welfare concerns, working dogs can be expensive to breed, raise, train and manage throughout their working lives [10, 11]. Failure to successfully train dogs can significantly increase costs and leads to additional inefficiency and wastage [4].

Working dogs perform important duties in many societies worldwide, adding social, cultural and economic value to human lifestyles. Community expectations toward animal welfare are changing. The public is increasingly seeking the assurance of ‘good’ animal welfare, not just the prevention of suffering [12-16]. In the case of kennelled working dogs today, animal welfare reflects the interplay between three key components: (1) human attitudes and behaviours, (2) the physical environment and facility management practices, and (3) the dogs. Where industry practices do not meet community expectations, the social licence to operate may be revoked, causing industry disruption or cessation of that type of animal use [17-19]. Examples of such interventions include recent suspension of greyhound racing and the livestock live export trade in Australia, and the phasing out of exotic animal circus performances in many locations globally [19-22]. Industries relying on animals will therefore need to be transparent in their actions and able to assure the public that the animals in their care experience good welfare if the industry is to be sustainable in the future. The success rate for working dog programs is approximately 50% across all industry sectors, i.e. around half of the dogs bred or purchased to become working dogs fail to become operational [4, 23]. Such inefficiency has obvious economic consequences, and it may also undermine public perception of this type of animal use. A loss of public confidence in the welfare of working dogs could risk the sustainability of these dog-based industries [17, 24].

Researchers have identified various elements of social and environmental enrichment that appear effective in reducing the stress of dogs housed in kennels [25]. Industry groups are responding by combining many of these tested elements in the provision of a composite enrichment program for the dogs housed in their kennel facilities. Such composite enrichment programs have not been objectively tested and risk overstimulating and adding to the stress of dogs housed in kennel facilities [26]. This may have a negative impact on the learning and performance of kennelled working dogs. A better understanding of the impact of kennel facility management practices on working dog welfare is required to improve the lives of animals while maintaining public confidence in working dog industries.

The rationale for this interdisciplinary thesis is ultimately to advance the welfare of working dogs by examining human attitudes towards and canine responses to kennel management practices relevant to the welfare and performance of working dogs. To achieve this aim, a survey was conducted to examine beliefs about the welfare of dogs in different contexts. The survey also noted the perceived importance of various kennel management practices to the welfare of dogs housed in kennel facilities. Attention was then directed to better understanding the physiological responses of young working dogs entering kennels and the impact of a composite enrichment program on working dog welfare and performance. The thesis also includes a novel contribution to improve methodology and interpretation when using salivary cortisol in the welfare assessment of dogs.

1.1. Overview of the thesis

Chapter 2 (published in *Behavioural Processes*) critically reviews the existing literature on the 'production' of working dogs, examining current knowledge regarding genetic selection, puppy rearing, recruitment and assessment, training, housing and husbandry, handler education, health and working life end-point management. It identifies the inefficiencies that contribute to the high failure rate of dogs in attaining operational status and proposes that scientific research and evidence-based improvements to animal welfare will be integral for the working dog industry to meet modern expectations.

Chapter 3 presents the results of a survey that explores the perceived welfare of dogs across 18 different contexts (refer Appendix 1 for survey questionnaire form). It demonstrates that people perceive the welfare of different working, companion and wild dogs to vary from extremely poor to

extremely high. The survey also found that many people consider the welfare of dogs to be important. This information can be used to help inform actions and effective resource allocation towards improved canine welfare. These findings indicate that a demonstrated commitment to public assurance that the welfare of dogs is a priority will be integral for working dog industry stakeholders wishing to maintain a social licence for the continued and sustainable participation of dogs in utility, service and entertainment roles. This manuscript has been accepted for publication in *Animal Welfare*.

Human beliefs about what is important to the welfare of kennelled dogs have been largely overlooked in the field of human-animal interactions. Chapter 4 seeks to address this gap by evaluating the perceived importance to the welfare of dogs of specific kennel management practices relating to canine health, kennel facility design and routine, social interactions and environmental enrichment. The findings show that attitudes differ significantly and may be contributing to occupational stress and staff turnover among employees in kennel facilities. The introduction of consistent regulatory standards to which all kennel facility operators are held accountable offers a way to ensure that dogs get what they require to live a good life while housed in kennel facilities. These results also suggest that future models designed to assess animal welfare should include the critical dimension of human-animal interaction. Finally, the findings highlight the need for improved engagement between researchers and industry stakeholders to ensure that new findings inform evidence-based industry practice to advance the welfare of dogs housed in kennel facilities. This manuscript has been submitted to *Applied Animal Behaviour Science*.

Chapter 5 (submitted to *Physiology and Behavior*) presents the findings of a pilot study that evaluated the suitability of the physiological markers salivary cortisol, salivary Immunoglobulin A and plasma neutrophil to lymphocyte ratio to measure stress in young working dogs. Suitability of the measures was demonstrated through the stability exhibited in a group of dogs that stayed in their puppy raising homes over the 30-day sampling period. In comparison, dogs that entered the training kennels showed a clear and significant effect on all markers, consistent with distress after admission to the kennel facility. It is possible that the stress of admission to the training kennel facility impacts on the capacity of dogs to learn and perform at optimal levels, affecting the success rate of the program. These results clarify the need to evaluate kennel facility management practices intended to reduce stress, such as composite enrichment programs, to determine their impact on the stress and performance of young working dogs.

Although many elements of social and environmental enrichment have separately been shown to help reduce stress in dogs housed in kennel facilities, the effect of a composite program combining many such elements has not been determined. Chapter 6 addresses this deficiency, demonstrating that access to a composite enrichment program did not increase physiological stress or negatively influence the performance of young working dogs housed in a kennel facility. The findings also highlight the complexities of using group means in research to assess the welfare of animals and suggest that an alternative method of statistical analysis may offer more meaningful insights where larger sample sizes are available. This chapter concludes that individualized programs of care will likely be required to optimize working dog welfare objectives and performance outcomes. This manuscript has been submitted to *Physiology and Behavior*.

Chapter 7 further explores the complexities of studying physiological stress responses in dogs by means of a systematic review and meta-analysis focused on the measurement of salivary cortisol, which is widely used in canine stress research, but poorly understood. This study (published in *Domestic Animal Endocrinology*) pooled the raw data from 31 experiments, enabling the meta-analysis to establish the range for salivary cortisol in domestic dogs as well as identifying significant effects of dog characteristics, environment and experimental design on salivary cortisol concentration. The identified intra- and inter-individual variability and effect of external variables on salivary cortisol concentration highlight the importance of exercising caution when interpreting published studies and carefully controlling the experimental design of future studies.

The welfare of dogs is considered very important to people. Consequently, the transparent assurance of the positive welfare of working dogs will be important to the future sustainability of using dogs in working and sporting roles. Chapter 8 provides a summary and general discussion of the findings of this thesis. The complex and multi-dimensional nature of human attitudes and canine responses to kennel management practices relevant to the welfare and performance of working dogs have been explored using multiple approaches. This chapter discusses the limitations of the studies, identifies future directions enabled by this body of work, and highlights the key implications of the thesis. Continued research into the welfare of working dogs should help to align industry practices with wider societal standards.

1.2. Thesis including published works: a note on structure

Monash University encourages PhD candidates to submit a 'thesis including published works', a thesis format including papers that have been submitted or accepted for publication during a student's candidature for their graduate research degree. The thesis is expected to reflect a sustained and cohesive theme. Six manuscripts are included in the body of this thesis, presented as peer-reviewed publications. As the chapters have been submitted to, and published in, different journals, formatting differs among chapters; some overlap and repetition of experimental properties therefore necessarily exists.

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Appendix 1. Survey questionnaire form

Attitudes regarding the welfare of dogs housed in kennel facilitiesPage 1 - **Perceived levels of welfare**

1. Throughout this survey you will be asked about your attitudes and perceptions relating to kennel facilities and the welfare of dogs. The term welfare is used to refer to the animal's quality of life.

This first question relates to the welfare of your pet dog. If you own more than one dog, please select only one of your dogs to answer about.

If you don't own a dog, please proceed to question 3.

Please rate the welfare of your pet dog today:

- ☐ Extremely low
- ☐ Low
- ☐ Neither High or Low
- ☐ High
- ☐ Extremely high

2. Please rate the welfare of your pet dog in general:

- ☐ Extremely low
- ☐ Low
- ☐ Neither High or Low
- ☐ High
- ☐ Extremely High

3. This question is about how you rate the welfare of different types of dogs. If you are unsure, please rate to the best of your knowledge.

Please select a level of welfare for each of the following dog types:

	Extremely low	Low	Neither High or Low	High	Extremely high
Stock herding farm dog (stock: cattle or sheep)	☐	☐	☐	☐	☐
Police dog (tracking, apprehending)	☐	☐	☐	☐	☐
Guide / Seeing Eye dog (for the visually impaired)	☐	☐	☐	☐	☐
Racing greyhound	☐	☐	☐	☐	☐
Stray (street) dog	☐	☐	☐	☐	☐
Drug detection dog	☐	☐	☐	☐	☐
Guard dog (property protection)	☐	☐	☐	☐	☐
Other people's pet dogs	☐	☐	☐	☐	☐
Pig hunting dog	☐	☐	☐	☐	☐
Assistance/Service dog (for the physically impaired)	☐	☐	☐	☐	☐
Wild (feral) dog	☐	☐	☐	☐	☐
Firearm/explosive detection dog	☐	☐	☐	☐	☐
Pedigree pure breed show dog	☐	☐	☐	☐	☐
Search and rescue dog	☐	☐	☐	☐	☐
Sled racing dog	☐	☐	☐	☐	☐
Plant/food detection dog	☐	☐	☐	☐	☐
Fighting dog	☐	☐	☐	☐	☐

4. Please indicate how strongly you agree or disagree with the following statement.

The welfare of dogs is very important to me.

- ☐ Strongly Disagree
- ☐ Disagree
- ☐ Neither Agree or Disagree
- ☐ Agree
- ☐ Strongly Agree

5. Compared to the average person, how do you rate your knowledge about dogs housed in kennel facilities?
- ☐ Extremely low
 - ☐ Low
 - ☐ Neither high or low
 - ☐ High
 - ☐ Extremely high

6. Have you ever worked at, or volunteered within, a kennel facility?
- ☐ Yes
 - ☐ No (please proceed to Question 9)

7. Which of the following best describes the type of kennel facility you have experience with?

If you have had experience in multiple kennel facilities, please select all that apply.

- ☐ Commercial boarding kennel facility
- ☐ Animal welfare shelter (eg. RSPCA, Animal Aid, Lost Dogs, Animal Welfare League, etc.)
- ☐ Council Pound
- ☐ Veterinary clinic kennel facility
- ☐ Breeding kennel facility
- ☐ Commercial training kennel facility
- ☐ Greyhound kennel facility
- ☐ Working dog kennel facility (eg. Guide Dogs, Customs, Police, etc.)
- ☐ If other, please specify

8. Which of the following best describes your role within the kennel facility you have most recently been involved with?
- ☐ Volunteer
 - ☐ Employed in Administrative (Office) role
 - ☐ Employed as Animal/Kennel Attendant (responsible for cleaning/feeding/direct care of dogs)
 - ☐ Employed as Veterinary Nurse (responsible for medications/supportive veterinary care)
 - ☐ Employed as Dog Trainer (responsible for training of dogs)
 - ☐ Employed as kennel facility Manager (responsible for facility operations)
 - ☐ Employed as Veterinarian (responsible for veterinary care of dogs)
 - ☐ If other, please specify

9. In what year were you born?

10. What is your gender?

11. Were you born in Australia?

12. If you were not born in Australia, in which country were you born?

13. What is your current residential post code?

(If you don't live in Australia, please write the name of the country that you live in)

14. Which of the following best describes where you live?

- ☐ City CBD
- ☐ Inner suburbs
- ☐ Outer suburbs
- ☐ Rural town
- ☐ Rural property
- ☐ If other, please specify

15. Which of the following best describes the residence you live in?

- ☐ House
- ☐ Unit
- ☐ Townhouse
- ☐ Flat/Apartment
- ☐ Other
- ☐ If other, please specify

16. Including yourself, how many adults (aged 18 years or over) live in your household?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

17. How many children (aged less than 18 years) live in your household?

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

18. What is the highest level of education you have reached?

- ☐ Completed primary school
- ☐ Completed part of secondary school
- ☐ Completed secondary school or equivalent
- ☐ Completed a TAFE course
- ☐ Completed an undergraduate university degree
- ☐ Completed a postgraduate university degree
- ☐ If other, please specify

19. What is your annual (gross) household income?

- ☐ Less than \$25,000
- ☐ \$25,001-\$50,000
- ☐ \$50,001-\$75,000
- ☐ \$75,001-\$100,000
- ☐ \$100,001-\$125,000
- ☐ \$125,001-\$150,000
- ☐ More than \$150,000

20. This question is about how you important you think different attributes of a kennel facility are to the welfare of dogs.

If you are unsure, please rate to the best of your knowledge.

How important are the attributes listed below to the welfare of dogs housed in a kennel facility?

	Extremely unimportant	Unimportant	Neither important or unimportant	Important	Extremely Important
Clean and hygienic environment	☐	☐	☐	☐	☐
Individual housing	☐	☐	☐	☐	☐
Free access to be inside or outside	☐	☐	☐	☐	☐
Vaccinations	☐	☐	☐	☐	☐
Relaxing music to listen to	☐	☐	☐	☐	☐
Variety of daily activities	☐	☐	☐	☐	☐
Social contact with other dogs	☐	☐	☐	☐	☐
Medications for health care	☐	☐	☐	☐	☐
Visual contact with other dogs	☐	☐	☐	☐	☐
Regular (free running) exercise	☐	☐	☐	☐	☐
Chew toys	☐	☐	☐	☐	☐
Predictable daily routine	☐	☐	☐	☐	☐
Playtime with other dogs	☐	☐	☐	☐	☐
Complete and balanced nutrition	☐	☐	☐	☐	☐
Lavender essence to smell	☐	☐	☐	☐	☐
Social housing with other dogs	☐	☐	☐	☐	☐
Provision of bedding raised above the ground	☐	☐	☐	☐	☐
Training sessions	☐	☐	☐	☐	☐
Access to clean water	☐	☐	☐	☐	☐
Ball toys	☐	☐	☐	☐	☐

21. This question continues to ask how important you think different attributes of a kennel facility are to the welfare of dogs.

If you are unsure, please rate to the best of your knowledge.

How important are the attributes listed below to the welfare of dogs housed in a kennel facility?

	Extremely unimportant	Unimportant	Neither important or unimportant	Important	Extremely Important
Grooming sessions	☐	☐	☐	☐	☐
Veterinary health checks	☐	☐	☐	☐	☐
Tug toys	☐	☐	☐	☐	☐
Feeding at least once daily	☐	☐	☐	☐	☐
Soft bedding (eg. blankets)	☐	☐	☐	☐	☐
Temperature controlled environment (ie. heating, cooling)	☐	☐	☐	☐	☐
Raw bones to chew	☐	☐	☐	☐	☐
Regular parasite control	☐	☐	☐	☐	☐
Shelter from elements (eg. wind, rain, sun)	☐	☐	☐	☐	☐
Recordings of human voices to listen to	☐	☐	☐	☐	☐
Regular walks outside of the kennel facility	☐	☐	☐	☐	☐
Substrates (sand, dirt, bark, etc.) to dig in	☐	☐	☐	☐	☐
Canine massage	☐	☐	☐	☐	☐
Access to water to swim	☐	☐	☐	☐	☐

Social contact with people	☐	☐	☐	☐	☐
Visual contact to outside the facility	☐	☐	☐	☐	☐

22. This question asks whether you agree or disagree with the following statements regarding enrichment activities and dogs housed in kennel facilities.

The term 'enrichment activities' refers to dogs getting access to toys, exercise, smells, sounds, different locations and contact with other dogs and people.

Please indicate your level of agreement with the following statements. If you are unsure, please rate to the best of your knowledge:

	Strongly Disagree	Disagree	Neither Agree or disagree	Agree	Strongly Agree
Dogs in kennel facilities are more relaxed when they have access to enrichment activities	☐	☐	☐	☐	☐
Dogs in training will perform better without any access to enrichment activities while housed in kennel facilities	☐	☐	☐	☐	☐
A dog's trainer should be the only source of positive attention and interaction	☐	☐	☐	☐	☐
Dogs housed in kennel facilities are not as well looked after as pet dogs kept at home	☐	☐	☐	☐	☐
Dog welfare is very important to the people who directly care for dogs in kennel facilities (animal attendants)	☐	☐	☐	☐	☐
Working dogs housed in kennel facilities for long periods are well looked after	☐	☐	☐	☐	☐
Dogs housed in kennel facilities don't need to have regular veterinary checks	☐	☐	☐	☐	☐
Enrichment activities help lower stress levels of dogs in kennel facilities	☐	☐	☐	☐	☐

23. This question continues to ask whether you agree or disagree with the following statements regarding enrichment activities and dogs housed in kennel facilities.

The term 'enrichment activities' refers to dogs getting access to toys, exercise, smells, sounds, different locations and contact with other dogs and people.

Please indicate your level of agreement with the following statements. If you are unsure, please rate to the best of your knowledge:

	Strongly Disagree	Disagree	Neither Agree or disagree	Agree	Strongly Agree
Dogs should not be housed in kennel facilities	☐	☐	☐	☐	☐
Stress helps to get the best performance from a working dog	☐	☐	☐	☐	☐
Enrichment activities hide behaviours of unsuitable working dogs until later in the training process	☐	☐	☐	☐	☐
Dogs housed in kennel facilities enjoy being with people more than other dogs	☐	☐	☐	☐	☐
Dogs housed in kennel facilities should have daily access to enrichment activities	☐	☐	☐	☐	☐

Dogs shouldn't be housed socially (in groups) because it's dangerous	☐	☐	☐	☐	☐
It's important that dogs housed in kennel facilities can see what is going on around them	☐	☐	☐	☐	☐
The way that kennel facilities are operated is directly related to the welfare of dogs housed there	☐	☐	☐	☐	☐
Playing classical music helps dogs to relax in kennel facilities	☐	☐	☐	☐	☐

24. This question continues to ask whether you agree or disagree with the following statements regarding enrichment activities and dogs housed in kennel facilities.

The term 'enrichment activities' refers to dogs getting access to toys, exercise, smells, sounds, different locations and contact with other dogs and people.

Please indicate your level of agreement with the following statements. If you are unsure, please rate to the best of your knowledge:

	Strongly Disagree	Disagree	Neither Agree or disagree	Agree	Strongly Agree
Some working dogs fail in their training because they get too stressed being housed in kennel facilities	☐	☐	☐	☐	☐
Dogs housed in kennel facilities prefer to spend time with other dogs rather than people	☐	☐	☐	☐	☐
Dog welfare is very important to the people who directly train dogs in kennel facilities (dog trainers)	☐	☐	☐	☐	☐
Providing enrichment activities to working dogs in training kennel facilities distracts them from their training tasks	☐	☐	☐	☐	☐
Spraying the kennel facility surfaces with lavender essential oil helps dogs to relax in kennel facilities	☐	☐	☐	☐	☐
Dogs get stressed when they first come into kennel facilities	☐	☐	☐	☐	☐
Dogs training to be working dogs should not have access to enrichment activities in kennel facilities because it masks their natural behaviour	☐	☐	☐	☐	☐

25. This question continues to ask whether you agree or disagree with the following statements regarding enrichment activities and dogs housed in kennel facilities.

The term 'enrichment activities' refers to dogs getting access to toys, exercise, smells, sounds, different locations and contact with other dogs and people.

Please indicate your level of agreement with the following statements. If you are unsure, please rate to the best of your knowledge:

	Strongly Disagree	Disagree	Neither Agree or disagree	Agree	Strongly Agree
Dogs can live in kennel facilities happily for over five years	☐	☐	☐	☐	☐
Working dogs that are kept in kennel facilities receive regular veterinary care	☐	☐	☐	☐	☐

Dogs housed in kennel facilities are easier to train than those housed in home environments	☐	☐	☐	☐	☐
Dogs who have access to enrichment activities are more stressed than those who don't	☐	☐	☐	☐	☐
Dog welfare is very important to the general public community	☐	☐	☐	☐	☐
Dogs shouldn't be housed in kennel facilities for more than six months at a time	☐	☐	☐	☐	☐
Lower stress levels in dogs housed in kennel facilities mean that more dogs can be successfully trained as working dogs	☐	☐	☐	☐	☐
Dogs that get stressed in kennel facilities during training shouldn't be placed as working dogs	☐	☐	☐	☐	☐
Lowering the stress experienced by dogs living in kennel facilities is good for their welfare	☐	☐	☐	☐	☐
All kennel facilities are the same from the dog's point of view	☐	☐	☐	☐	☐

26. What do think is the most important consideration for the welfare of dogs housed in kennel facilities?

Chapter 2

The advent of canine performance science: offering a sustainable future for working dogs.

Mia Cobb^a, Nick Branson^b, Paul McGreevy^c, Alan Lill^d and Pauleen Bennett^e

^a Anthrozoology Research Group, School of Psychological Sciences, Monash University, Victoria, Australia

^b Deakin Research, Deakin University, Waurin Ponds, Victoria, Australia

^c Faculty of Veterinary Science, University of Sydney, New South Wales, Australia

^d School of Biological Sciences, Monash University, Victoria, Australia

^e Anthrozoology Research Group, School of Psychological Science, La Trobe University, Bendigo, Victoria, Australia

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Abstract

Working and sporting dogs provide an essential contribution to many industries worldwide. The common development, maintenance and disposal of working and sporting dogs can be considered in the same way as other animal production systems. The process of 'production' involves genetic selection, puppy rearing, recruitment and assessment, training, housing and handling, handler education, health and working life end-point management. At present, inefficiencies throughout the production process result in a high failure rate of dogs attaining operational status. This level of wastage would be condemned in other animal production industries for economic reasons and has significant implications for dog welfare, as well as public perceptions of dog-based industries. Standards of acceptable animal use are changing and some historically common uses of animals are no longer publicly acceptable, especially where harm is caused for purposes deemed trivial, or where alternatives exist. Public scrutiny of animal use appears likely to increase and extend to all roles of animals, including working and sporting dogs. Production system processes therefore need to be transparent, traceable and ethically acceptable for animal use to be sustainable into the future. Evidence-based approaches already inform best practice in fields as diverse as agriculture and human athletic performance. This article introduces the nascent discipline of canine performance science, which aims to facilitate optimal product quality and production efficiency, while also assuring evidence-based increments in dog welfare through a process of research and development. Our thesis is that the model of canine performance science offers an objective, transparent and traceable opportunity for industry development in line with community expectations and underpins a sustainable future for working dogs.

Key words: working dogs; welfare; sustainability; canine performance science; wastage

1. Introduction

Domestic dogs are represented in a wide range of contexts; as companions, guardians, stock herders, detectors, guides, assistants and as racing participants in sporting entertainment. These roles are sometimes indistinct, in that some dogs bred as companions may find themselves in working roles, some bred for work may end up living as domestic companions, and others may perform dual roles, perhaps working during the week and being a companion on weekends. This paper's focus is on working dogs identified by their functional context, acknowledging they do not always fall exclusively into distinct categories or placement on a continuum. In this discussion, we define a working dog as any domestic dog that is operational in a private industry, government, assistance or sporting context, independently of whether it also performs a role as human companion. This diversity of roles has led to fragmented public perceptions of working and sporting dogs, but the private, government, assistance and sporting sectors share many commonalities and can be considered as sectors of one broad working dog industry (Branson, Cobb, and McGreevy 2012). Working dog roles are generally undertaken by dogs for reasons of economy, ease or ability; either humans or machines cannot do the task, or it is cheaper or easier for a dog to do it.

Although research assessing economic contributions from working dogs is limited, a recent estimation of Australian stock herding dogs calculated AUD\$40,000 as the median value of a herding dog's lifetime work (Arnott et al. 2014) typically providing a 5.2-fold return on investment. The cost to obtain a livestock guardian dog has been estimated as returned

through stock retention within 1-3 years of the dog starting work (van Bommel and Johnson 2012). The investment of resources to breed and train a guide dog to operational standard for placement with a person with visual impairment has been valued at up to USD\$50,000 (Wirth and Rein 2008). The economic value once placed with a handler with a vision impairment has not been extensively assessed, but research demonstrates positive changes to guide dog handlers' definitions of self, social identity and public interaction are significant (Sanders 2000). Across private industry, government, assistance and sporting sectors, working dogs add value and are valuable.

This is an important point because, although limited, available data suggest that success rates generally average 50% across working dog industry sectors (Branson, Cobb, and McGreevy 2010; Arnott et al. 2014; Slabbert and Odendaal 1999; Maejima et al. 2007; Batt et al. 2008; Wilsson and Sundgren 1997; Sinn, Gosling, and Hilliard 2010). This means that around half of all dogs being bred, or considered to work or race, fail to become operational. This so-called wastage is problematic for the financial sustainability of the industry, with considerable room for improvement, and subsequent economic advantage, being evident. It is also problematic in terms of public perceptions of the sector (Spedding 1995). To determine where industry inefficiencies exist that contribute to this wastage rate, we draw on the emerging field of canine performance science to objectively assess the life cycle of working dog development. We also argue the importance of examining public attitudes so that issues of potential importance can be identified and monitored prior to industry disruption. This paper outlines the relevance of canine performance science to the

future sustainability of dog-based industries and sporting groups as an important future direction in canine science.

2. What impacts sustainability of working dog production?

An overwhelming body of evidence confirms domestic dogs are social athletes capable of providing humans with emotional support and a wide range of health benefits. While we fully acknowledge dogs' sentience and intrinsic value, working dog programs can be objectively considered within the framework of an animal production system. Examples of other animal production systems include those that produce livestock for use in agriculture, or laboratory animals for medical experimentation. Although domesticated animals exist in many forms, from livestock animals through to companion species, evidence suggests that human-dog relationships may be particularly enduring and unique (Shipman 2011). Human attachment to dogs may differ from attachment to other animals (Zasloff 1996), and these inconsistencies can result in animal protection legislation safeguarding animals in some contexts more strongly than others (O'Sullivan 2007). It is therefore important for industry stakeholders and scientists alike to remain mindful of possible bias in our perceptions and to clarify both the commonalities and differences of human interactions between various animal species (Zasloff 1996) and in the complex case of domestic dogs, the potential for this variation to occur within a species.

Genetic selection, rearing of young animals, recruitment and assessment processes, housing and handling, training techniques, handler education, and health and end-point

management are all aspects of this production system that can affect the quality of the final product: the working dog. It is important to emphasise that, in this context, the term *quality* no longer refers only to the observable end product. Of critical import are the efficiency of the production system and the ethical framework used to prevent, or sometimes justify, any compromised welfare of the animals' involved (Broom 2010). Broom (2010) asserts that animal production systems that are not sustainable will not be present in the future. A system that is inefficient or results in poor animal welfare is likely to be unsustainable because it fails to align with the general public's values (McGlone 2001; Broom 2011). Growing awareness of the implications of animal use and management for welfare have led to rising public expectations and lower levels of tolerance for conditions perceived as inadequate. Animal welfare issues are demonstrably important to the general public and therefore relevant to governments responsible for establishing minimal levels of care. For example, more letters are received by European Union (EU) parliamentarians relating to animal welfare than any other issue and led to the development of EU legislation to improve animal welfare (Blokhuys et al. 2003; Horgan and Gavinelli 2006; Ransom 2007; Broom 2010).

As information technology and social media make producers more accountable to the public, and as more dogs are permanently identifiable with microchips and registry tracking, the contemporary production processes will face increased pressure to be transparent, traceable and ethically acceptable for animal use to be sustainable. Present day efficiencies in communication mean that the consequences of unacceptable animal production methods are potentially more damaging to producers (Broom, 2010). This has

been routinely illustrated by the impact of public attitudes on animal industries following media exposés, which increase normative pressure through shock, strengthening the empirical credibility of particular debates (Elzen et al. 2011; Nath et al. 2012; Tiplady, Walsh, and Phillips 2013). Although recent debate highlights the importance of developing metrics for good welfare (Yeates and Main 2008; Broom 2011), most stakeholders focus on searching for evidence of suffering or distress when assessing the need for change (Whay 2007). Such metrics are becoming more sophisticated and informative with every sequential report (Arnott et al. 2014), and these measures may one day be used to assure the public that working dog welfare is a high priority.

Shifts in public attitudes illustrate change to perceptions of acceptable animal use and social licence to operate (Wells and Hepper 1997; Goodfellow, Tensen, and Bradshaw 2014). For example, setting animals to fight one another is outlawed and the display of exotic animals for entertainment, for example in circuses and zoos, is currently under scrutiny (Hughes 2001; Hutchins 2006; Beauchamp 2008; Melfi 2009; Whitham and Wielebnowski 2013). Continuation of this trend will lead to examination of animals in other utility roles, such as working dogs. Community attitudes regarding animal welfare are important to the future sustainability of the working dog industry. General community attitudes drive societal expectations and can influence government and industry regulations that oversee acceptable standards of care. At present, the perceived welfare of dogs varies from very poor to very good across different companion, working and sporting roles (Hubrecht 1995; Serpell 2004; Taylor and Signal 2009; Buckland et al. 2013; Buckland et al. 2014; Cobb, Lill, and Bennett 2014). This is most evident in the popular press, where

many stories raise concern about the welfare of racing dogs (Russell 2007; McDonald 2012; Rubinsztein-Dunlop 2013), but coverage of dogs working in therapy or service roles rarely raise the issue of the welfare of the dogs involved (Hooper 2014; Rose 2014). Some sectors within the working dog industry (e.g. greyhound racing) are completely dependent on public enthusiasts to operate as viable economical enterprises. Proactive demonstration of positive welfare initiatives, reduced wastage, clear communication of transparent processes, traceability of animals and informed continuous improvement toward best practice are important means by which animal industries can recruit public support (McGlone 2001; Gamborg and Sandøe 2005; Broom 2010). Therefore, ongoing monitoring of public perceptions, beliefs and attitudes will be required to assess progress, justify innovations and identify new directions. An observed outcome of increased sensitivity to animal well-being is that producers, users and government agencies request scientific information about animal welfare (Broom 2010, 2011; Ohl and van der Staay 2012). Scientific research efforts offer much to advance the welfare of working dogs and contribute to improved industry efficiency and reduced wastage. However, these research and development efforts are currently spread across multiple disciplines pertinent to working dog production and performance, lacking unity under the banner of a distinct field.

2.1 Dogs: breeding, recruitment and assessment

Acquisition policies are central to most working dog operations and the manner in which dogs are sourced for various types of work varies widely, influence industry efficiency and can have welfare implications (Rajapaksha and Dangolla 2008). There is merit in standardizing terminology and selection process to reduce ambiguity and confusion,

enabling accurate prediction of adult traits to be made in puppyhood (Early et al. 2014). One example is dogs used for roles requiring common traits, such as '*drive*', a motivational characteristic defined by one industry group as "the propensity of a dog to exhibit a particular pattern of behaviours when faced with particular stimuli" (SWGDOG, 2011). '*Drive*' is reportedly a trait valued in all detector dogs, regardless of the specific goal being detected, and is also used in relation to livestock herding dogs and racing greyhounds, however the term is ascribed to different behaviours in each context (Branson, Cobb and McGreevy, 2010; 2012; Early et al. 2014).

The quest for early prediction of adult traits has triggered significant scientific endeavour in an attempt to determine the age at which individual dogs can be identified as successful working dogs. Some reports have described considerable success in this domain (Slabbert and Odendaal 1999; Russenberger and Clothier 2008; Batt et al. 2008; Sforzini et al. 2009) while others (Goddard and Beilharz 1983, 1984) report that behavioural tests conducted on young pups (<7 weeks) have low repeatability and predictability of adult behaviour. For example, with a focus on predicting so-called dominance behaviour later in life, Beaudet, Chalifoux, and Dallaire (1994) concluded that the value of behavioural tests and activity level measures increases with age. This is supported by Burghardt (2003) who found that the predictive value of tests rapidly increased until at least 6 months of age in Belgian Malinois dogs. In addition, Champness (1996) found that adult dog performance in detection aptitude tasks within the Australian Customs program could be predicted to some degree in puppies from three months of age onwards. Despite this research, there remains a current tendency among the diverse working dog industry sectors for

stakeholders to work in isolation and with a lack of cohesion, even where dogs are being bred, raised and trained for similar duties (for example, illicit substance detection in Correctional services, Customs, Police and Military).

Selecting breeding dogs to produce working stock often relies on rigorous training and testing of potential candidates, at considerable expense. While success rates should improve with the use of early suitability indicators, such indicators rely first on identification of markers (genetic or phenotypic) that bear a strong association to training outcomes. Behavioural markers measured at early ages provide weak predictors of success (Goddard and Beilharz 1986). To date, the efficiencies of studies to assess genetic loci corresponding to behavioural phenotypes in dogs have been affected by insufficient samples, the inability to control for the environments of phenotyped individuals and by inconsistency in the phenotyping measures employed (van Rooy et al. 2014). However, such limitations are surmountable by phenotyping animals from similar environments with standardised assessments, obtaining dense genotypic marker information on all animals, and sufficient sampling density to attain statistical power (Lit, Belanger, Boehm, Lybarger and Oberbauer 2013; Lit, Belanger, Boehm, Lybarger, Haverbeke, et al. 2013). Successfully managing a working dog breeding program requires the accurate identification of suitable working dogs. This may be achieved using phenotypic analyses such as Estimated Breeding Values (Leighton 1997; Mackenzie, Oltenacu, and Leighton 1985). Secondly, assuming these traits are heritable, integration of genetic information for individual dogs with the broader resources available for each dog is required; using assessments of genetic diversity and the

integration of genetic marker information through the use of genotyping arrays (Maejima et al. 2007).

Working dog units that purchase animals from external breeders or have their own breeding program may reduce wastage by clearly defining and evaluating their specific long-term needs and thus refining the phenotypic variance (Scott and Fuller 1974; Branson, Cobb, and McGreevy 2010; Mehrkam and Wynne 2014). As with any best practice canine breeding program, strategic consideration must be given ahead of time to: anticipated fluctuations in workload requirements to avoid overbreeding; selection of suitable breeders to avoid inbreeding; and regard for important long-term health traits (McGreevy and Nicholas 1999; McGreevy 2007; Rooney et al. 2008; Collins et al. 2010). Various external sources (e.g. shelters and donation of public pets) may be useful sources of working dogs that have behavioural traits unsuitable for companion homes (McGreevy 2007), but some of the dogs offered for adoption may have learned to be fearful or evasive (Marston and Bennett 2003) and so may be more problematic to train than dogs recruited as pups. Similarly, reliably assessing the behaviour of dogs housed in shelters remains an ongoing challenge (Taylor and Mills 2006; Mornement et al. 2010, 2014) and further research investment in this area is required. The importance of specialist breeding and task specificity may not be pivotal for success in some working roles, and it is possible to recruit working candidates from community pounds, animal shelters or rescue groups (Weiss and Greenberg 1997; Weiss 2002). Although preliminary information suggests this is not the most efficient way of sourcing suitable dogs (Branson, Cobb, and McGreevy 2010), further data collection in this area will add clarity. External sources were the most commonly

reported supply of working dogs reported in the Australian Working Dog Survey 2009 (Branson, Cobb, and McGreevy 2010). This somewhat random approach to the recruitment of working dogs from external sources highlights the risk of 'behavioural wastage' - reduced success rates in training dogs to perform specific tasks - an outcome that has consequences for both animal welfare and also industry productivity and efficiency (McGreevy and McLean 2007).

Suitability for specific tasks is arguably the area in which most working dog research has been done; with numerous peer-reviewed publications on canine personality and temperament assessments (Serpell and Hsu 2001; Taylor and Mills 2006; Fratkin et al. 2013). The subjectivity and lack of consistency of so-called temperament tests in dogs has been criticized (Beaudet, Chalifoux, and Dallaire 1994). For example, Murphy (1998) and Fuchs et al. (2005) emphasized that subjective assessment criteria increased the variability of results. Another issue is that response to assessors can be much less repeatable than response to environmental stimuli. Netto and Planta (1997) showed that responses may be context-specific rather than generalized, with dogs often responding with aggressive behaviour to one stimulus but not others. Others have reviewed and outlined ways to design and conduct tests to ensure assessments of canine temperament are reliable, valid and feasible (Jones and Gosling 2005; Taylor and Mills 2006).

An understanding of canine behaviour is relevant to the way we conduct working dog personality profiling, recruitment and selection assessments. Relationships between personality attributes, temperament characteristics and individual dog behaviours within and between breeds are important determinants in working dog success. The impact of certain

attributes on a dog's ability to work will undoubtedly influence the tools used to select canine workers. It is proposed that affective state can strongly influence operant conditioning outcomes (Starling, Branson, Cody, et al. 2013) and that the shy-bold super-trait varies with the age, breed and sex of dogs (Starling, Branson, Thomson, et al. 2013, 2013b). Furthermore, it is clear that behaviour co-varies with dogs' height, bodyweight and head shape, so we are becoming better at defining what behaviours are normal for dogs of a given morphology (McGreevy et al. 2013; Georgevsky et al. 2014).

Dogs show tremendous morphological variation between breeds and this is frequently accompanied by differences in behaviour, particularly reactivity (Bradshaw, Goodwin, et al. 1996). Several behavioural traits have been shown to be influenced by breed. For example, Svartberg (2002) found German shepherd dogs to be 'bolder' than Belgium Tervurens, and Guy et al. (2001) found smaller breeds of dogs to be involved in more aggressive incidents than larger breeds. In addition, Ennik et al. (2006) found that German Shepherds were less successful than Labrador Retrievers or Golden Retrievers as guide dogs. Goodwin, Bradshaw, and Wickens (1997) also found that the purpose for which dogs were bred significantly influenced their behaviour, possibly indicating the need for greater emphasis to be placed on task-specific breeding programs. As genetic technologies advance, it becomes possible to make informed decisions when selecting and breeding working dogs. Obtaining information on the relatedness of dogs, and breeding predominantly from dogs with quantifiable behavioural traits and known parentage, improve the chances of producing operational individuals.

2.2 Dogs: early rearing and training

The associations between training, assessment and performance are emerging. Meyer and Ladewig (2008) examined the effect of the duration of training, and frequency and length of individual sessions and concluded that the optimal combination may vary with breed and training context. In a study of Belgian military working dogs, it was concluded that dog handler teams should train more regularly and adopt training systems that rely on the use of more positive training methods, an increased training frequency, and improved education of the trainers relating to learning theory (Haverbeke et al. 2008). A survey of dog owners by Hiby, Rooney, and Bradshaw (2004) found that punishment by owners was associated with an increased incidence of problematic behaviours. Similarly, Haverbeke et al. (2008) found that military dogs punished using aversive training techniques had lower performance scores. Since problematic behaviours can be caused by, or result in, a state of anxiety, they may be associated with compromised welfare. It is plausible to conclude that punishment of dogs with an anxiety disorder will directly compromise dog welfare. Consequently, a uniform approach to the empirical study of dog training may not be appropriate.

Recent research examining dogs bred for work in the Swedish armed forces has added to existing evidence that a dog's early environment can have long-lasting effects on their behaviour and coping styles in a stressful test situation (Foyer et al. 2014; Foyer et al. 2013). The effectiveness of structured sessions for juvenile socialisation and training have been questioned (Batt et al. 2008), however appropriate exposures to kennels (Rooney, Gaines, and Bradshaw 2007), home environments (Pfaffenberger and Scott 1959; Appleby, Bradshaw, and Casey 2002) and people (Gazzano et al. 2008; Udell, Dorey, and Wynne

2010) have been demonstrated as significant in reducing stress and altering long term behavioural outcomes, factors important to improving working dog industry efficiency.

The term behavioural wastage (McGreevy and McLean 2007) has been used to describe the loss of animals from an industry for reasons related to training or an innate response. Collection of baseline data on training styles and current behavioural wastage rates would allow risk factors for behavioural wastage to be analysed to improve industry efficiency, delivering better animal welfare outcomes. The development of technologies that measure interactions between trainers and their animals, such as those currently being utilized in equitation science to measure rein tension between horse and rider (McGreevy 2007; Goodwin et al. 2009), is particularly encouraging. These may serve to overcome current problems presented by the widespread use of subjective terms (such as 'drive' and 'willingness' and 'instinct') in working dog assessment and training reports (Murphy 1998). It appears there may be opportunity for scientists and working dog industry members to collaborate towards improving objectivity and efficiencies. Further investigation into the training and assessment methodology used throughout the various working dog sub-sectors seems merited.

2.3 Personnel: policies and handler education

The exposure of dogs to multiple personnel is of interest since it can have both positive and negative welfare outcomes (Fallani, Previde, and Valsecchi 2006; Lefebvre et al. 2007; Haverbeke et al. 2008; Horvath, Doka, and Miklosi 2008). Any change in trainer may be an opportunity to cross-check progress and eliminate training deficits but it may

also increase the chances of inconsistency or introduce negative effects of severance of the human-animal bond; outcomes likely to compromise the quality of conditioned responses and possibly generate conflict (O'Brien et al. 2008; Palmer and Custance 2008; Horn, Huber, and Range 2013). This issue indicates the importance of consistent and rigorous assessment of trainers' ability, so that protocols are understood and adhered to. This ensures that the onus is shifted from an individual trainer's own skills and motivation, to apply quality assurance to the training protocols themselves. With the ongoing collection of meaningful data in mind, we see value in standardized measures of human-dog interactions (McGreevy et al. 2012).

Interest in this domain is highlighted by the emergence of various commercial, further education, and online dog training qualifications. It may well be worth considering a central accreditation scheme that creates recognized benchmarks in dog training best practices. Such a scheme could follow the modern quality assurance standards system of routine review, ongoing development and improvement, with internal and external auditing processes. Given that few independently certified dog training education opportunities are currently offered, further investigation of the relationship between trainer/handler education levels and dog training methodology seems warranted (Branson, Cobb, and McGreevy 2010). In this context, it is worth considering how widely learning theory is applied in working dog training (Browne et al. 2011; 2013). For example, a trainer with a sound theoretical education and ability to practice the basic principles of reinforcement may be of more benefit than an informally trained specialist who has worked only with one breed, or even one select working dog role within a breed.

Despite a wealth of publicly available knowledge on dog behaviour and training, there is little information regarding the optimal behaviour and personality profile of those who train dogs. Certain individuals are recognised as ‘dog people’, due to their proficiency at training and interpreting the body language of the dogs under their care. However, no objective data exist on what makes these individuals so skilled. It is now understood that two characteristics common to effective trainers are consistency and accurate timing, which allows the animals to know precisely when and how to respond to a command (McGreevy and Boakes 2007; Browne et al. 2011; 2013). With this knowledge, however, there is still no guarantee of experiencing good results in practice. Therefore, a knowledge gap exists concerning what defines the great dogmanship of expert handlers and how to translate it into the actions of others (Payne et al., submitted). This demands a novel means to upskill dog handlers to ensure optimised performance from their animals, while maintaining good animal welfare.

The equipment and materials (e.g. chain; leather; etc.) used in dog training are often selected based on traditional practices and they may be subject to various levels of acceptance and fashion. The appropriateness of equipment used to restrain dogs (including: check chains, flat collars, martingale/limited slip collars; body piece harnesses and head harnesses) cannot be separated from the way in which they are used. Recent research has quantified the pressure load associated with different styles of guide dog harness, illustrating significant differences among the harnesses which are likely to affect dog-handler interaction (Peham et al. 2013). Best practice often has more to do with technique than equipment, but collars that offer a softer interface between the trainer and

the dog are generally more forgiving and reduce the impact of excessive force or poor timing, so are favoured from a welfare perspective. Training techniques involving choke chains, prong collars and even flat collars are capable of mechanical or ischemic damage to the larynx, oesophagus, thyroid, trachea, brain and increased intraocular pressure (Grohmann et al. 2013; Brammeier et al. 2006; Pauli et al. 2006). Meanwhile, the use of shock (electric) collars remains highly contentious (Ogburn et al. 1998; Haug, Beaver, and Longnecker 2002; Schilder and van der Borg 2004; Overall 2007, 2007b; Schalke et al. 2007; Steiss et al. 2007).

Purely from a productivity perspective, research shows that interactions between human handlers and their animals can limit the welfare and performance of the animals (Hemsworth, Barnett, and Coleman 2009; Coleman et al. 2000; Coleman et al. 2003; Hemsworth, Coleman, and Barnett 1994; Sorge et al. 2010; 2012; Sorge et al. 2014). This field has found that the attitudes of handlers serve as a strong predictor of handler behaviour towards the animals. By way of extension, the ProHand stockperson handling programs for pork and dairy livestock have demonstrated the ability of a training program to modify human attitudes that have a direct effect on animal fear, productivity and welfare (Coleman et al. 2000; Hemsworth et al. 2002; Coleman et al. 2003; Hemsworth, Barnett, and Coleman 2009). This program relies on changing established habits and altering well-established attitudes and beliefs. Improved animal handler job satisfaction, motivation and work performance have been beneficial outcomes of ProHand. Not only does the animal function well from handling, performance and welfare perspectives, but the handler's job

becomes more enjoyable as animals are easier to manage, leading to increased productivity and consequent economic benefits (Hemsworth, Barnett, and Coleman 2009).

The success of cognitive-behavioural interventions in improving key attitudes and behaviour of stock people in some livestock industries highlight the potential benefit of adopting similar training programs in other animal industries, offering significant opportunities for industries to improve the welfare of their animals and, by default, productivity outcomes. To underestimate the role and impact of the dog trainer and handler on the dog has the potential to seriously jeopardise the welfare, performance and productivity of working dogs. This underpins the emerging interest in the dog-human dyad and the attributes that characterise successful bonds between members of the two species (McGreevy et al. 2012). Exploring which characteristics of canine morphology may lead to handlers ascribing anthropomorphic traits, such as guilt, is an interesting development in this area (Hecht and Horowitz 2013). The anthrozoology of interactions between humans and horses has been effectively categorised to provide a template of how to interact with horses safely (McGreevy et al. 2009) and has been shown to deliver excellent results under the banner of equitation science (Goodwin et al. 2009; Hawson, McLean, and McGreevy 2010; McLean and McGreevy 2010). The same approach would be beneficial for the dog-human dyad under the focussed auspices of canine performance science. Application and success of training programs may also be influenced by the environment in which the dog is trained and housed.

2.4 Environment and husbandry: housing, health care and transport

The types of shelter provided to working dogs are almost as varied as the contexts in which dogs work. Shelter can vary with time of day and the location of work. As opportunists, dogs may make the most of whatever comfort is available but some types of housing may be wholly inadequate. Farm dogs, for example, may spend significant periods on the back of vehicles, in cages or chained, and may be exposed to extreme environmental elements in the process (Arnott et al. 2014). Whenever housing is considered, the associated needs for social and environmental enrichment deserve particular attention (Hubrecht 1993; Loveridge 1998; Taylor and Mills 2007; Timmins et al. 2007).

Working dogs are often housed in kennel facilities favouring ease of maintaining hygiene and housing maximum numbers, but these may not meet the behavioural needs of domestic dogs (Hubrecht 1993). This can result in dogs experiencing behavioural and physiological stress in response to being housed in a kennel facility (Hennessy et al. 1997; Beerda, Schilder, Bernadina, et al. 1999; Beerda, Schilder, Van Hooff, et al. 1999; Rooney, Gaines, and Bradshaw 2007). Individual housing was more frequently reported for working dogs in the Australian Working Dog Survey 2009 than social housing with either conspecifics, humans, or both (Branson, Cobb, and McGreevy 2010). While this may eliminate the risk of injury through fighting and offer some form of disease control, it can compromise welfare by failing to meet the dog's species-specific need for social interaction, including physical contact. Environmental and social enrichment, such as access to toys and group housing, have been shown to reduce the stress responses of dogs housed in kennel facilities (Hubrecht 1993; Coppinger and Zuccotti 1999; Wells and Hepper 2000;

Wells 2004; Lefebvre, Giffroy, and Diederich 2009; Pullen, Merrill, and Bradshaw 2010). However, research in this area is often limited to distinct populations with small subject groups and studies of short duration (Taylor and Mills 2007), indicating an opportunity for collaboration between industry groups and researchers to learn more about this area that could contribute to improved performance and reduced industry wastage (de Azevedo, Cipreste, and Young 2007). Many working dogs are privately owned and are consequently housed on private properties and out of the public eye. At this stage, with very little information available (Jerram 2013; Arnott et al. 2014), we can only speculate as to the wide range of housing conditions such dogs may experience.

The extent to which management of working dogs contrasts with that of the wider companion dog population merits close scrutiny. However, using the example that 75% of Australian dogs are in single dog households and that levels of daily exercise are low (Kobelt et al. 2003; Kobelt et al. 2007), it may be wrong to assume that companion dogs have a better level of welfare. In the best scenarios, the intrinsic value of many working dogs suggests that they may receive more regular veterinary check-ups than companion dogs and that the expense of veterinary treatments is less of an obstacle to comprehensive care (Branson, Cobb, and McGreevy 2010). However, a study conducted in Australia in 2001 (Buckley 2002) found that more than two-thirds of the farmers surveyed would not spend more than AUD\$500 to save an injured working dog's life. Yet most farmers reported they would need to employ an extra 1-3 people to complete the same work without the assistance of their working dog (Buckley 2002; Virgona 2008). More recent research in this area revealed that farmers would spend a median of AU\$1,001-2000 to treat their best

working dog for an illness or injury to allow it to return to work (Arnott et al. 2014). Surveys conducted to establish the current status of welfare among dogs working on farms in Australia found that 28% (Virgona 2008) to 31% (Arnott et al. 2014) of surveyed farmers had lost their previous working dog due to a lethal accident in the course of their work. However, until conclusive data are collected one cannot assume that the health of detector dogs, for example, is comparable to that of farm dogs or racing greyhounds that are perceived as having lower welfare (Cobb, Lill, and Bennett 2014) and reported as being more dispensable (Atkinson and Young 2005; Jackson 2001).

Despite a large number of studies investigating the effect of transportation on laboratory animals, pigs, poultry, sheep, horses and cattle (Kuhn et al. 1991; Scott 1994; Smith et al. 1996; Bradshaw, Parrott, et al. 1996; Grandin 1997; Wickham et al. 2012), we found very little published information regarding the effects of confinement and transportation on working dogs (Bergeron et al. 2002; Leadon and Mullins 1991). This is surprising given the amount of time farm, government and racing dogs spend contained in crates or on vehicles during the course of their operational work, associated transportation and non-operational time.

There is a clear need for further research to better understand the acute and chronic effects of transport, housing and environment as sources of distress, and the relation of these to the overall health and welfare of working dogs. It would also be useful to investigate interactions between stress and performance in working dogs and whether manipulation of housing environment (including opportunities for social and environmental enrichment) might, in turn, improve the welfare, performance and efficiency of working dog

programs. Taken together, these underline the need for coordinated research to monitor and optimize welfare and productivity in working dog sectors.

2.5 Dogs: retirement and end point management

The reasons for a dog in training subsequently failing as a working dog are complex but merit scrutiny because they can reflect a combination of fluctuations in demand (Batt et al. 2008), individual differences in learning abilities, or health issues (e.g. a dog with an inherited disorder will have only a brief working life). As with all assessment stages in trained animals, failures may also emerge as a result of deficiencies in the application of learning theory (McGreevy and Boakes 2007). Any audit of working dog training programs must attempt to capture the trainability and health of the dogs, the training techniques and the skill with which they are applied. However, once dogs have joined the working population, it seems that they are more likely to leave prematurely because of disease or injury (Lorenz, Coppinger, and Sutherland 1986; Moore et al. 2001; Evans et al. 2007), rather than training or handling deficits. A guide dog health survey conducted in the United States in 2008 found that orthopaedic problems, skin problems and cancer were key health issues reported by handlers in either their current or previous working dog (Olson 2008). Nevertheless, behavioural issues may arise if the working context proves more challenging than the training period (Lefebvre et al. 2007; Haverbeke et al. 2008).

There are limited statistics on the average age of dogs working or the average age at which they retire. The Australian Working Dog Survey 2009 (Branson, Cobb, and McGreevy 2010) reported that the average age of working dogs was highest in assistance (5.3yo) and

government (4.6yo) industry groups and lowest in the private (3.6yo) and sporting dog (3.5yo) group responses. Retirement age ranged from 2-14yo across the industry. The collection of additional data of this kind could be used to calculate the relative working longevity and wastage rates across working dog industry sectors, informing strategies to improve working performance longevity and identify risks to industry efficiency.

The destination of dogs leaving each industry sector is also of considerable interest. Those with inappropriate behaviour for one type of work may be transferred to another working context where the challenges are reduced or different. For example, the air force may acquire a general purpose police dog for guard patrol purposes; or a potential guide dog for the visually impaired assessed as too scent-distracted and excitable may be transferred to train in detection work. This is consistent with the environmental sustainability strategy of *Reduce, Reuse, Recycle*, which promotes efficient utilisation of resources and reduction of waste (Barr 2003), although its application to animals and consequences for animal well-being have not been assessed to our knowledge.

Working dogs may be retired and kept within the same environment or transferred to a new environment as a companion animal. It is acknowledged that some working dogs that fail to meet operational standards due to training failure, health reasons or retirement are considered unsuitable as pets and may be euthanased. Methods of destruction are of concern from an animal welfare and public awareness perspective (Jackson 2001). Greyhounds Victoria (the peak body for greyhound racing in the state of Victoria, Australia) has adopted the requirement of a veterinary euthanasia certificate for greyhounds, as suggested by Burghardt (2003). However, private sector contexts, such as farm and

property protection guard dogs, currently lack the capacity for such regulation or enforcement and exit data for dogs no longer able to work effectively in these sub-sectors are not routinely documented. Arnott et al. (2014) reported that 21% of operational Australian stock herding dogs were euthanased on retirement.

The reasons for dogs leaving work should inform any strategy that seeks to prioritize the use of resources to make dog use more efficient. Such information would also help to grade the relative welfare impact of various training, health and management issues. Critical indicators of success in dog training and dog use include the proportion of trainee dogs reaching a working standard and longevity within the working role. Trends in these metrics could be utilized to reflect the effectiveness of long-term strategies designed to enhance productivity and welfare.

2.6 Canine performance science: opportunity for interdisciplinary and industry collaboration

Millman et al. (2004) concluded that improvements in animal welfare and production efficiency are most likely to occur when the following criteria are met: public concerns are addressed; there are economic advantages associated with the changes, and; networks exist to facilitate the transfer of new information and to coordinate activities through industry and legislative sectors. In the absence of objective scientific data as a reference point, stakeholders cannot specify how to deal with animals in a morally appropriate way (Ransom 2007). Benchmarking, validating and developing working dog industry processes using canine performance science is the way forward. By combining data on behavioural, physiological, cognitive and physical metrics, this paradigm provides the opportunity to

objectively evaluate working dog learning, performance and coping mechanisms (Beerda et al. 1996; Rooney, Gaines, and Bradshaw 2007; Burman et al. 2011).

This manuscript has reviewed current scientific endeavours in areas relative to working dog development and performance. We note there exist a limited, but growing, number of opportunities and resources enabling scientists and working dog industry practitioners from all sectors to easily communicate and collaborate (Rooney, Gaines, and Hiby 2009). There is ample evidence that, when the different professions and industries combine their research efforts, new ground is broken for the benefit of both humans and non-human animals (Salvin et al. 2010; 2011). Similarly, new directions in canine behaviour research should embrace the proposed interdisciplinary framework of canine performance science. This achievement is seen in human athletic research institutes where athlete recruitment, learning, performance and longevity are optimised for individual and team sporting pursuits through new research (Pearson, Naughton, and Torode 2006; Phillips et al. 2010; Gulbin et al. 2013). Investment in these research and development programs has demonstrated a significant linear relationship with performance outcomes (Hogan and Norton 2000).

3. Conclusion

Research informs us that the welfare and productivity of working dogs can be compromised across all areas of production. It is important that objective, reliable and valid scientific information be readily accessible to compete with other information reaching working dog stakeholders, namely industry, government, animal welfare advocates and the

general public. Canine performance science can inform how to concurrently improve welfare and working dog industry production efficiencies, such as learning and performance outcomes. Interdisciplinary collaboration is critical to the success of canine performance science in its intersecting goals of optimising product quality and production efficiency whilst assuring evidence-based increments in dog welfare. This paradigm can inform proactive industry development that is objective, transparent and traceable in the light of community expectations and will underpin an ethically sound and sustainable future for working dogs.

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Chapter 3

Not all dogs are equal:

Perception of canine welfare varies with context.

ML Cobb^a; A Lill^b; PC Bennett^c

^a School of Psychology and Psychiatry
Building 17, Clayton Campus
Wellington Rd, Monash University
Victoria, Australia, 3800

^b School of Life Sciences
Department of Ecology, Environment and Evolution
BS2, Melbourne (Bundoora) Campus, La Trobe University
Victoria, Australia, 3806

^c Anthrozoology Research Group
School of Psychology and Public Health
Bendigo Campus, La Trobe University
P.O. Box 199, Bendigo
Victoria, Australia, 3552

Abstract

Community attitudes drive societal expectations, influencing government and industry regulations that determine standards of care for industries reliant on animals. It is important for dog industry stakeholders to understand public perceptions and attitudes, to inform management strategy priorities relating to animal welfare. This study sought to determine if the welfare status of dogs is important to people and whether the perceived level of welfare varies with dog context (e.g. companion, protection, stock herding, assistance, sporting, free-roaming, wild, etc.). Over 2,000 self-selected adults completed a voluntary, internet-based questionnaire. Responses were received from more than twelve countries and from a range of stakeholders with varied experiences. Perceived welfare status of dogs varied significantly across 17 dog contexts and roles, from extremely low (e.g. Fighting dogs) to very high (e.g. Guide dogs). Over 95% of respondents agreed that the welfare of dogs was very important to them. Demographic features of respondents did not relate to meaningful differences in reported importance of canine welfare or ratings of perceived welfare of dogs. The constructs underlying how people perceive the welfare of dogs appear complex and multi-dimensional. As public scrutiny forces reassessment of the welfare status of animals used in various contexts, pro-active management of perceived welfare issues by companion and working dog industry stakeholders, including government, industry organisations, advocacy groups, and animal welfare researchers, is likely to be key to the sustainable participation of dogs in these roles.

Keywords: Animal welfare; Attitudes; Dogs; Public; Sustainability; Working dogs

Introduction

General community attitudes drive societal expectations and consequently influence government and industry regulations that govern recommended standards of care for animals (Verbeke 2009). Several studies, including those by Coleman et al (2003) and Rohlf et al (2012), demonstrate that perceptions and attitudes determine human behaviour towards animals, and that human behaviour governs the welfare of animals in our care. Animal welfare is a growing consideration for the sustainability of industries utilising animals (Broom 2010; Cobb et al 2015; Kasperbauer 2018), and so it is important for industry stakeholders to understand how people perceive the welfare of animals in different contexts.

Domestic dogs are currently found in a wide range of contexts, including companion, research, security, stock herding, detection, assistance and sporting roles, as well as urban stray and ecological feral niches. The wide range of settings in which domestic dogs can be found attracts a diversity of industry stakeholders. These include regulators at industry group and government levels, animal advocacy groups and those involved directly with the daily management of dogs, such as veterinarians, veterinary nurses, facility managers, breeders, trainers, handlers, animal management officers and primary care givers (e.g. kennel attendants), in addition to the general public. Identifying any differences in perceived animal welfare will allow for pro-active communication and education with transparency by industry and management groups. Such action should ideally be taken prior to worker or community dissatisfaction, subsequent media exposé, legal action or industry disruption. Examples of such disruption have been seen recently in the Australian livestock (Ferguson et al 2014; Goodfellow et al 2014; Tiplady et al 2013) and New South Wales racing greyhound (Baird 2016; Burritt & Christ 2016; Markwell et al 2017) industries.

Attitudes towards animals and their treatment can vary by animal type and how they are perceived (Sims et al 2007). For example, research has shown that people's attitudes towards animals kept as companions differ from those perceived as pest species and also those categorised as commercially valuable animals managed for profit. These differences are thought to be underpinned by our assessment of the animals' perceived intrinsic and extrinsic significance, or a lack thereof (Taylor & Signal 2009). Thus the 'Pet, Pest, Profit' scale, developed by Taylor and Signal (2007), suggests that humans perceive more value in animal companions than in animals kept for profit or categorised as pest species. Studies have also shown that pet ownership can relate to attitudes and beliefs relating to animals and their use in different contexts (Driscoll 1992; Toukhsati et al 2007).

In addition, Serpell (2004) proposes that people's emotional response to animals (Affect) and their perception of the animals' instrumental value (Utility) provide the foundation for human attitudes to non-human animals. This model acknowledges the influence of an individual's culture, maturation, personality and experience with animals, in addition to the attributes of the specific focal animal (Serpell 2004). To date, the perceived welfare of one species, living in multiple contexts and undertaking numerous roles relating to humans, such as the domestic dog, has not been examined directly. Informed by these models, it is likely that human attitudes towards dogs may vary, depending on the context in which the dogs are found.

Canine welfare issues have attracted attention and research over the past decade; for example, the investigation of canine inherited breeding disorders (Beausoleil & Mellor 2014; Collins et al 2011; Rooney et al 2008; Summers et al 2010), and management of free-roaming dog populations (Farnworth et al 2012; Slater et al 2008; Tenzin et al 2015). These studies

understandably focus on dogs in only one context. However, a broader perspective offering insight into the perceived welfare of dogs across a variety of contexts could aid prioritisation of activities intended to improve the welfare of dogs, such as research funding, or the development of educational materials.

This study was conducted to determine if the perceived level of canine welfare varies with the context of the dog's role and whether the welfare status of dogs is considered important to people.

Materials and Method

Questionnaire and participant recruitment

After reviewing the relevant literature, a questionnaire was developed that comprised four sections. The first section asked respondents if they were currently dog owners (1 item) and, if they were, requested that they rate the welfare of their own dog today, and in general (2 items) using a five-point Likert-style scale that varied from Extremely Low to Extremely High. Survey participants were instructed *'The term welfare is used to refer to the animal's quality of life. This question asks you to rate the welfare of different types of dogs. If you are unsure, please rate to the best of your knowledge'*. No further definitions of 'welfare' or 'quality of life' were provided, as we wanted to gauge people's perceptions without priming their responses. In the second section of the questionnaire, all participants were asked to rate how they perceived the welfare of dogs in different roles (17 items) using the same five-point Likert-style scale that varied from Extremely Low to Extremely High. The contexts for dogs, outside of those owned by respondents, were limited to 17, with a primary focus on working dogs, our key area of interest. Dogs not in working dog roles (such as feral wild dogs, pet companion

dogs and pedigree show dogs) were included to provide perspective as to how the welfare of working dogs is perceived in relation to other domestic dogs. The survey software randomised presentation order of dog contexts for rating. The third section of the questionnaire asked respondents to agree or disagree with the statement “The welfare of dogs is very important to me” (1 item) on a five-point Likert scale that varied from Strongly Disagree to Strongly Agree. The final section sought demographic features of respondents (15 items), including country of residence, highest level of education attained, residence locality and household descriptors, and if they had work or volunteer experience relating to dog kennel facilities. A copy of the questionnaire can be obtained from the corresponding author by request. The questionnaire and project were approved by the Monash University Human Research Ethics Committee (Project number: CF09/2370 – 2009001379).

Self-selected, voluntary, adult participants ($n = 2,309$) responded to the internet-based questionnaire that was hosted on a secure website and distributed using various social media platforms, web forums and email distribution. The data presented in this study were collected over a 15-week period, concluding 31 December 2009, and are likely biased toward respondents with positive attitudes about animals. One hundred and sixty-three responses were discarded as unfinished; 2,146 complete responses were retained for analysis.

Participants

Most responses came from Australia (55.3%), the UK (13.9%) and the USA (12.1%). Responses received from Canada, Ireland, New Zealand, South Africa, Denmark, Norway, Germany, Spain and Finland accounted for a further 9.7% of participants, with the remaining 6% of participants coming from other minimally represented countries. Some respondents (3%) chose not to disclose their home country. Respondents were 81% female, 17% male and

2% not specified, which is consistent with similar research in this field (King *et al* 2009; Mornement *et al* 2012; Rohlf *et al* 2010). Participant age ranged from 18 to 84 years (mean = 37.43, $SD = 12.70$). Table 1 provides additional demographic information.

Table 1. Demographic details of survey participants (n = 2146)

Variable		Percentage
Gender	Female	81
	Male	17
	Not specified	2
Age (years)	18-29	29
	30-39	27
	40-49	18
	50-59	12
	60+	6
	Not specified	8
Highest level of education completed	Primary School	<1
	Part of Secondary School	4
	Completed Secondary School	22
	Vocational/TAFE/Trade School	15
	Undergraduate University Degree	33
	Postgraduate University Degree	23
	Not specified	3
Household income	Less than \$25,000	10
	\$25,001-\$50,000	13
	\$50,001-\$75,000	16
	\$75,001-\$100,000	16
	\$100,001-\$125,000	10
	\$125,001-\$150,000	7
	More than \$150,000	11
	Not specified	17
Number of adults in household	One	18
	Two	49
	Three	13
	Four	6
	Five or more	2
	Not specified	12
Number of children in household	Zero	69
	One	10
	Two	8
	Three	2
	Four or more	1
	Not specified	10
Household locality	City (Inner/Central Business District)	6
	Inner Suburbs	27
	Outer Suburbs	32
	Regional/rural town	14
	Regional/rural property	11
	Other	1
	Not specified	9

The majority of respondents (82%) currently owned a dog, and 43% had past or present employment in a kennel facility. Table 2 provides additional employment information.

Table 2. Dog ownership and kennel facility experience details of survey participants (n = 2146)

Variable	Percentage
Dog owner	No 18
	Yes 82
Previous or current employment in kennel facility	No 53
	Yes (detail below) 43
	Not specified 4
Type of experience (most recent role)	Volunteer 42
	Animal Attendant 21
	Dog trainer 12
	Veterinary Nurse 9
	Administrative 7
	Facility Manager/Owner 7
	Veterinarian 2
Type of experience (kennel facility)	Animal welfare shelter 30
	Commercial dog boarding 17
	Vet clinic 17
	Working dog 10
	Commercial breeding 10
	Council pound 9
	Commercial training 4
	Greyhound racing 3
Experience working in multiple types of kennel facility	24

Statistical analyses

Descriptive statistics were compiled for demographic data and the item relating to the importance of canine welfare to respondents. Preliminary analysis using multivariate analysis of variance showed that country of origin was not a significant factor in participant ratings of canine welfare, so data from all respondents were combined for the main analyses. Analyses were undertaken using the IBM SPSS Statistics 25 software package. The assumptions of normality underlying analyses were met following visual inspection of histograms, expected normal probability plots, de-trended expected normal probability plots and box plots, which all support that the data are approximately normally distributed. Skewness and kurtosis values indicate no substantial departure from normality (West, *et al* 1995) across dog contexts, with the pooled data exhibiting skewness of -0.41 (SE = 0.01) and kurtosis of -0.95 (SE = 0.03). A one-way repeated measures analysis of variance (ANOVA) with post-hoc pairwise comparisons based on marginal means (and Bonferroni probability adjustment for multiple comparisons) was conducted to compare perceived welfare scores across the 17 types of domestic dog contexts listed. Subsequent analyses (one-way ANOVA and independent sample t-tests) were conducted to identify where the significant differences relating to respondents' demographic features lay. Effect size is always reported where statistically significant findings were identified.

Results

Importance of dog welfare to people

Most respondents (95%) agreed or strongly agreed that the welfare of dogs is very important to them (Table 3). An independent-samples t-test was conducted to compare agreement with the statement 'The welfare of dogs is very important to me' for males and females. There was a statistically significant difference with scores for males ($M = 4.41$, $SD = 0.91$) lower than females ($M = 4.72$, $SD = 0.78$; $t(2107) = -6.73$, $P = <0.001$, two-tailed). However, despite reaching statistical significance, the magnitude of difference in the means (mean difference = 0.31, 95% CI: -0.41 to -0.21) was quite small (eta squared = 0.02). Further independent-samples t-tests showed a statistically significant difference in scores for dog owners ($M = 4.73$, $SD = 0.76$) and non-owners ($M = 4.34$, $SD = 0.96$; $t(2145) = 7.52$, $P = <0.001$, two-tailed). The difference (mean difference = 0.40, 95% CI: 0.29 to 0.50) in the means was small (eta squared = 0.03). A one-way between-groups analysis of variance revealed a statistically significant difference between respondents who had completed secondary school or equivalent ($M = 4.79$, $SD = 0.59$) and those who had completed an undergraduate ($M = 4.62$, $SD = 0.87$) or postgraduate university degree ($M = 4.59$, $SD = 0.85$): $F_{(2, 2066)} = 4.04$, $P = 0.001$. Again, the difference in mean scores had a very small effect size (eta squared = 0.01). Respondent age, experience working in kennels, presence of children in the household, household income and locality were not related to a statistically significant difference in scores on this variable.

Table 3. Self-rated items (% response)

Variable	Strongly disagree (1)	Disagree	Neither agree or disagree	Agree	Strongly agree (5)
The welfare of dogs is very important to me (n = 2146)	3.2	0.4	1.7	16.3	78.4
	Extremely low (-2)	Low	Neither low or high	High	Extremely high (2)
Rate the welfare of your dog today (n = 1765)	0.3	0.3	3.7	38.7	57.0
Rate the welfare of your dog in general (n = 1765)	0.3	0.3	2.0	41.0	56.4

Perceived welfare of domestic dogs in different contexts

Perceived welfare scores are presented as varying between -2 (Extremely low) and 2 (Extremely high), with 0 representing the neutral welfare score of Neither high or low, to clearly illustrate the valence of perceived welfare. The mean and standard deviation of the perceived welfare rating for each dog context type is presented in Table 4. The ANOVA used to compare perceived welfare ratings for each dog context showed a significant effect for dog type (Wilks' Lambda = 0.13, $F_{(16, 2130)} = 892.86$, $P < 0.0005$, multivariate partial eta squared = 0.87). Thus, perceived welfare of domestic dogs varied significantly, and with a very large effect size, with the context or role of the dog. Post-hoc pairwise comparisons between all contexts can be seen in Appendix 1.

Table 4. Mean perceived welfare rating (-2 = extremely low, 0 = neither high or low, 2 = extremely high) and SD for domestic dogs in different contexts (n = 2146)

Dog type	Perceived welfare rating	
	Mean	Standard deviation
Fighting dog	-1.53	1.05
Stray/street dog	-1.36	1.09
Feral/wild dog	-0.79	1.14
Racing greyhound	-0.47	1.17
Guard (property protection) dog	-0.34	1.04
Pig hunting dog	-0.34	1.09
Pedigree pure bred show dog	0.44	1.14
Sled racing dog	0.49	1.00
Farm livestock (cattle/sheep) herding dog	0.53	0.94
Other people's pet (companion) dog	0.55	0.73
Firearm/explosive detection dog	0.89	0.96
Plant/food detection dog	1.03	0.79
Police (tracking/apprehending) dog	1.11	0.79
Drug detection dog	1.13	0.79
Assistance/service dog (to physically impaired)	1.15	0.77
Search and rescue dog	1.18	0.70
Guide/seeing eye dog	1.28	0.77
Own pet (companion) dog, in general	1.53	0.59

Although the range for responses varied from Extremely low (-2) to Extremely high (2) (Table 3), over 95% of respondents rated their own pet (companion) dog as having an 'Extremely high' or 'High' perceived welfare rating (Own Dog [Today] $M = 1.52$, $SD = 0.62$; Own Dog [In General] $M = 1.53$, $SD = 0.59$). The welfare of other people's pet (companion) dogs was rated lower ($M = 0.55$, $SD = 0.73$, refer Table 4). Independent-samples t-tests conducted to compare the ratings for dog owners and non-owners showed the only statistically significant difference, using a Bonferroni adjusted alpha level of 0.003, was

perceived welfare rating for Sled racing dogs (Dog owners $M = 0.53$, $SD = 0.98$; Non-owners $M = 0.32$, $SD = 1.05$; $t_{(2144)} = 3.50$, $p = 0.001$; eta squared = 0.006). However, the difference in the means was very small. For all other contexts, ratings of perceived canine welfare did not differ significantly between dog owners and non-owners. There was no significant difference in perceived welfare of dogs between those with voluntary, non-voluntary employment, or no experience with kennel facilities.

Discussion

This study demonstrated that people's perception of the welfare of domestic dogs varies from extremely low to extremely high, depending upon the context or role of the dog. This investigation is the first of its kind to illustrate that the perceived welfare of one animal species varies across 17 different contexts in our society and the environment. The findings represent respondents' beliefs and opinions and are not easily explained using previous models that attempt to decipher our attitudes towards the treatment of animals, such as the 'Pet, Pest, Profit' model (Taylor & Signal 2009) and 'Affect-Utility' model (Serpell 2004). Differences in ratings of participants grouped by demographic features achieved statistical significance, but with a small effect size on some items, most likely as a result of the large sample size (Pallant 2016), or possibly recruitment bias. These differences were of a very minor magnitude, with little practical importance. By comparison, the role or context of the dog explained a very large amount of the variance in perceived welfare scores.

Respondents rated stray/street and feral/wild dogs as having low levels of welfare. Dogs that have recently been displaced from companion homes into stray or street contexts probably do experience reduced welfare. Free roaming dogs are often associated with

abandonment, personal safety and disease risks, and threat to wildlife or livestock (Dalla Villa *et al* 2010, Villatoro *et al* 2019). However, people living in areas with established populations of these dogs will commonly cite the dogs' welfare as a concern and will advocate for non-lethal solutions (Farnworth *et al* 2014; Slater *et al* 2008). Some wild populations, such as dingoes in Australia, are protected as a native species within national parks, while simultaneously being declared a pest across much of the country, where they are subject to control measures such as shooting and poisoning (Hyttén 2009). However, in several sections of their seminal book, Coppinger and Coppinger (2016) suggest that wild and free-ranging dogs may enjoy a better quality of life than many companion or working dogs in first world settings, given their comparative social, behavioural and reproductive freedom.

Dogs used for fighting, in greyhound racing, as guards (property protection) and in pig hunting had the lowest perceived welfare ratings of owned dogs included in the questionnaire. Such low perceived welfare ratings could flag future issues relating to the public support and social licence to operate for individuals and industry groups utilising dogs in these ways. Social licence (sometimes also referred to as public licence) to operate can be understood as the public acceptance or approval of the activity by the general population and stakeholders. In relation to the companion, working and sporting industry sectors in which dogs participate, stakeholders include the general public, government legislators, veterinarians, industry employees and animal welfare advocacy groups. Indeed, the racing greyhound industry in the Australian state of New South Wales was recently scrutinised and the sustainability of ethically concerning practices relating to training methods and so-called wastage have been questioned at community, media and government levels (Baird 2016; Burritt & Christ 2016; Markwell *et al* 2017).

The perceived welfare of pedigree pure-bred show dogs was lower than dogs kept in pet (companion) contexts and many of the working dog roles. This may reflect increasing awareness of the known health and welfare concerns affecting many pedigree pure-bred dogs, such as inherited defects linked to breed standards (Asher *et al* 2009), exaggerated anatomical features (e.g. brachycephalic obstructive airway syndrome; Beausoleil & Mellor 2015), and prevalence of other inherited disorders in dogs from a closed breeding pool (Rooney & Sargan 2010).

Welfare of sled-racing dogs and farm livestock-herding dogs was rated about the same as that of other people's pet (companion) dogs. Both of these contexts involve dogs that may participate across companion, recreational and commercial roles (Arnott *et al* 2014, Fennell & Sheppard 2011). Exposure to forces of weather, housing conditions, and level of risk inherent in the work of these dogs may impact their perceived welfare.

Dogs living closely aligned with humans in professionalised working dog roles (such as guide/seeing eye dogs, assistance dogs, drug detection dogs and police dogs) were perceived as having high to very high levels of welfare. Perception of the life experience of dogs in these working roles may be influenced by trust in brand association, media representation, hero dog affiliation, or the assumption that dogs of high social value are well maintained. This flags a potential area of concern, in that the welfare of dogs in these kinds of well-known working roles may often be assumed to be very high, when the reality may not always reflect this perception. There is ongoing global, scientific attention directed toward improving the welfare of dogs kennelled and trained in these working contexts (Bray *et al* 2017; Broach and Dunham 2016; Burrows *et al* 2008; Cobb *et al* 2015; Denham *et al* 2014; Hayes *et al* 2018; Rooney *et al* 2009; Serpell *et al* 2006; Toffoli & Rolfe 2006).

Although dog owners rated the welfare of their own dogs most highly, both dog owners and non-owners rated the welfare of other people's pet dogs similarly, close to 'Neither High or Low'. This may represent a bias in the self-selected participants in this study, reflecting that they may be highly motivated caretakers of their canine companions. Alternatively, it may suggest a self-enhancement bias, or positive illusion in belief, similar to that seen in other studies of self-assessed driving (Roy & Liersch 2013) and parenting skills (Wenger & Fowers 2008). Owners have demonstrated limited ability to correctly identify early stages of stress in their canine companions, with research reporting one in five owners believe stress has no physical or psychological consequences for their dog (Mariti et al 2012). This suggests some owners may not possess the knowledge to accurately assess the welfare of the dogs they live with. As a preliminary investigation, this study did not seek additional information about respondents' own dogs. For example, age, breed, how many dogs have been owned previously, or whether cohabiting dogs might fall into more than one context (e.g. pet companion and livestock herding). This is a limitation of the design and something that future research in the area should be careful to accommodate.

It is important to note that the results of this study do not reflect the actual welfare experience of dogs in these various roles; attitudes and beliefs underpin our findings. Fishbein and Azjen (1972) provide an excellent overview of how belief formation may occur. Drawing on their analysis, it is possible that respondents based their ratings of dog welfare on beliefs formed through direct observations of dogs in various contexts. Alternatively, ratings may be based on inferred assumptions regarding the quality of care given to dogs based on other factors (such as assumed purchase price, owner or organisation prestige, perceived social value of the dogs' role). A third possibility is that respondents were relying on external sources to inform their beliefs. In this regard, marketing and media relating to professionalised

working dogs' roles as 'Hero Dogs' (Aiello 2012), and the subsequent 'halo effect' may be influencing the belief that these dogs enjoy a high level of welfare. Farnworth and colleagues (2011) found that concern for the welfare of cats in New Zealand varied based on their description as 'stray' or 'feral'. Future research in this area should aim to identify the factors that underlie people's beliefs and opinions about the welfare of dogs in different roles. Retesting respondents would provide an indication of the test-retest reliability of these results, perhaps yielding additional information about uncertainty of beliefs at individual and population levels, but was unfortunately beyond the scope of this investigation.

The data presented in this study were collected in 2009 and may not be representative of the general community or all cultures. The key findings that perceived welfare of dogs varies with context and that people perceive the welfare of their own dog as better than other people's dogs are nonetheless unaffected by these limitations and are novel. Although it did not relate to a significant difference in results for this study, nearly half of the participants had voluntary or paid work experience in a kennel facility, most commonly in animal welfare shelters, boarding kennels and veterinary clinics. These people may be more highly motivated to participate in a study with a focus on the welfare of dogs. It is important for additional investigation in this area to endeavour to determine the attitudes and beliefs of a representative sample. Future research should examine the stability of perceived welfare of dogs in various contexts across time, and in light of the changes in information sharing with the increased use of social media over the last decade.

Future research in this area should aim to identify the factors that underlie people's beliefs and opinions about the welfare of dogs in different roles. For example, it could identify what importance respondents assign to features such as perceived usefulness, likeability,

prestige, transparency of training processes, purchase cost, physical health, intra- and inter-specific social opportunities, longevity, etc. when determining how people rate the dogs' perceived welfare. Different organisations or individuals raising and training dogs for similar roles may use completely different breeding and rearing processes, house dogs differently, and train the dogs with vastly differing methodologies, but this survey asked for overall ratings for dogs in that context, not allowing participants to specify any limits or assign confidence ratings to their perceived welfare scores. Enabling respondents to include additional detail or such limits when reporting their perceptions would provide additional information to aid interpretation of results. Exploring what people believe the terms 'welfare' and 'quality of life' mean when applied to dogs is also an area warranting additional research investment. Although this study provided 'quality of life' as a definition of 'welfare' it is not clear that all respondents interpreted this in the same way. Although working and sporting dogs live public lives in many ways, their husbandry is often undertaken out of public view, in kennel facilities or on private property. It is possible that many people don't know what is involved in the everyday training and care of these dogs. Surveying the perceived importance of various kennel management practices to the welfare of kennelled working dogs, and any differences across stakeholder groups, would be informative.

The tenets of naturalness, health and humane treatment are reported as central to what people consider good animal welfare (Clark *et al* 2016). When evaluating animal welfare, people think about the life the animal is living as well as the emotions the animal may be experiencing (Robbins *et al* 2018). When welfare is considered as a thick concept in philosophy, moral views about the acceptability of various human-animal interactions are likely to alter opinions about how an animal is faring (Robbins *et al* 2018). Applying the notion of naturalness to animals living under human control is challenging; scrutiny of the topic

suggests that when people notice an unnatural state, we have a responsibility to ensure that we have not made those animals' lives worse (Yeates 2018). The social legitimacy of greyhound racing seems to have eroded significantly, with decreasing public tolerance as greyhound racing is perceived by many as outdated and systemically cruel (Markwell *et al* 2017). This may explain why racing greyhounds, despite having lifestyles that share commonalities with other working dog contexts (i.e. housed in kennel facilities, people employed to train and care for them, regular training sessions and veterinary checks, etc.) are perceived as having low welfare, when other working dog roles that serve human interests with a degree of responsibility, beyond entertainment, are perceived as having high welfare. It appears that perceived welfare is influenced by, or acts as a reflection of the perceived social legitimacy of, the role or context that the dog is fulfilling.

Dogs in roles of responsibility who work closely with a human handler were perceived to have high welfare levels. In addition, respondents who lived with a canine companion rated the welfare of their own dog as very high. When people perceive animals as human-like, they are more likely to have empathy for them (Amiot & Bastian 2015). In addition, research shows that when anthropomorphized animals have apparent human qualities, such as friendliness and intelligence, humans perceive more similarity and show higher pro-social behavior toward them (Sevillano & Fiske 2016). It is possible that the anthropocentric responsibilities of these professionalized working dogs and the family member status of highly valued companion dogs may produce a similar effect, informing how their welfare is perceived. To consider that dogs living in roles of such perceived significance and closeness to humans could lead a life of compromised welfare may be uncomfortable for many people, possibly causing cognitive dissonance. People often need to reduce cognitive dissonance by describing animals as wanting to be, or benefiting from being utilized (Plous 2003). Cultural customs and utilitarian

views held by people may also limit their capacity to feel emotions, such as pity or compassion toward animals (Sevillano & Fiske 2016). This study has shown that the welfare of dogs is considered very important to most people, and that they perceive the welfare of different working, companion and wild dogs from extremely low to extremely high. This information can be used to help inform actions and effective resource allocation towards improved canine welfare (Reed and Upjohn 2018). A challenge ahead lies in identifying if people will advocate and act for uniform welfare standards for this species, the domestic dog, across the many roles and contexts we find them in today.

Conclusion and animal welfare implications

This study has shown that the welfare of dogs is considered very important to most people, and that they perceive the welfare of different working, companion and wild dogs from extremely low to extremely high. This information can be used to help inform actions and effective resource allocation towards improved canine welfare (Reed and Upjohn 2018). A challenge ahead lies in identifying if people will advocate and act for uniform welfare standards for this species, the domestic dog, across the many roles and contexts we find them in today. The constructs underlying how people perceive the welfare of dogs are clearly complex and multi-dimensional, deserving of additional exploration. It is hoped that future research will further explore the welfare of dogs in these sometimes difficult-to-access populations, as transparency of processes and an increased evidence base about the physiology and behaviour of dogs kept in these roles would inform industry, government and public stakeholders. Consumers have been shown to change their behaviour based on the perceived welfare of livestock animals, indicating that perception of animal welfare can be a significant trigger for human attitudinal and behavioural change. This

may signal that for dogs perceived to have lower welfare, human attitudes and behaviour may change. This may be evident by industry groups requiring that participants demonstrate continuous improvements in welfare standards, or alternatively in the removal of the social licence to operate for activities such as greyhound racing, or in societal trends away from owning pedigree dogs. A demonstrated commitment to assuring the public that the welfare of dogs is a priority will be integral to ongoing social licence for the continued and sustainable participation of dogs in utility, service and entertainment roles.

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Perception of canine welfare varies with context

Chapter 3 – Appendix 1

Appendix 1. Post-hoc pairwise comparison results (adjustment for multiple comparisons: Bonferroni) showing significant difference (P value; NS: not significant) of welfare rating based on dog contexts.

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Chapter 4

Perceived importance of specific kennel management practices for the provision of canine welfare.

MC Cobb^{a*}; A Carter^a; A Lill^b; PC Bennett^c

*corresponding author

^a Turner Institute of Brain and Mental Health and the School of Psychological Sciences
Building 17, Clayton Campus, Wellington Rd, Monash University
Victoria, Australia, 3800

^b Department of Ecology, Environment and Evolution, School of Life Sciences,
Melbourne Campus, La Trobe University,
Victoria, Australia, 3086

^c School of Psychology and Public Health
Bendigo Campus, LaTrobe University, P.O. Box 199, Bendigo
Victoria, Australia, 3552

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Abstract

There is considerable public interest in the welfare of dogs that spend at least part of their lives housed in kennel facilities, such as working and sporting dogs. The impacts of living in environments that limit social, physical, and behavioral opportunities are generally well understood in other animals, such as livestock and zoo animals. Research exploring the effects of the kennel environment and its enrichment on the behavior and physiology of dogs is emerging. However, human perceptions concerning what is important to the welfare of kenneled dogs have been overlooked. What people believe is important will influence their behavior, with direct relation to care provided to animals and the underlying social license of related industries to operate. This study evaluated the perceived importance of specific kennel management practices relating to canine health, kennel facility design and routine, social interactions, and environmental enrichment. Over 2,000 self-selected adults completed a voluntary, internet-based questionnaire. Differences in beliefs and attitudes were identified based on kennel facility experience, employment role, age, and gender, highlighting potential areas of discordance that may contribute to occupational stress and staff turnover. The results also suggest that research findings published in the scientific literature may not be successfully translating into evidence-based changes in industry practice. Future models to assess animal welfare should include the critical dimension of human-animal interaction. The beliefs, attitudes, and consequent behaviors of people interacting with dogs housed in kennels will determine how living in captivity impacts upon the experiences and welfare of the resident dogs.

Keywords: Animal welfare; Attitudes; Dogs; Enrichment; Kennels; Working Dogs

1. Introduction

There is considerable public interest in the welfare of dogs that spend at least part of their life housed in kennel facilities, such as working and sporting dogs. Many dogs are required to be housed in kennel environments for periods ranging from days to years. Dogs may be housed in veterinary clinics, rescue shelters, commercial training, breeding and boarding facilities, research settings, and sporting and working kennel facilities. These dogs include racing greyhounds, dogs kept to herd livestock or for hunting, security and guard dogs, government detection dogs (i.e. police, customs, biosecurity and military dogs), and guide, seeing eye and assistance dogs. Dogs in these various roles may live in kennels during any or all life stages; from birth, through puppy rearing, training and while operational in their sporting or working role (Branson et al., 2010).

Kennel facilities are typically designed for ease of maintaining hygiene and housing numerous individuals safely and securely in a limited amount of space (Hubrecht, 1993). Because of this, they are often considered to be barren and isolating, and consequently unable to fulfill dogs' behavioral needs (Hubrecht, 1993; Taylor and Mills, 2007). When animals are subjected to negative experiences such as confinement, loneliness and frustration, or when other physical, functional and affective needs are not met, animal welfare is compromised (Broom, 2007; Mellor, 2016). This can impact on learning, performance and the sustainability of using animals in these contexts (Cobb et al., 2015). The welfare of dogs is important to the general public (Cobb, Lill, & Bennett, in press). Failure to meet community expectations may threaten the social license required to utilize dogs in such contexts (Coleman, 2018; Duncan et al., 2018).

The impacts of living in environments that limit social, physical and behavioral opportunities on other animals, such as commercial livestock and zoo animals are generally well understood (Carlstead et al., 2013; Sherwen et al., 2015; Beausoleil et al., 2018; Hemsworth, 2018). However, investigations exploring the effects of the kennel environment and its enrichment on the behavior and physiology of dogs are still emerging (Rooney et al., 2007; Taylor and Mills, 2007; Titulaer et

al., 2013; Herron et al., 2014; Protopopova, 2016). The legislated minimum standards of care for the design and operation of kennel facilities usually reflect the traditional ‘Five Freedoms’ model of animal welfare, which has been in use since 1979, following the 1965 Brambell Report (Brambell, 1965; Broom, 2011). The five freedoms model proposed to mitigate suffering and negative experiences for animals through certain provisions (Webster, 2001; Mellor, 2016):

1. Freedom from hunger and thirst and malnutrition (by provision of ready access to fresh water and adequate diet to maintain full health);
2. Freedom from discomfort (by providing an appropriate environment that allows for shelter and rest);
3. Freedom from pain, injury or disease (by prevention and/or through provision of rapid diagnosis and treatment);
4. Freedom to express normal behavior (by providing sufficient space, resources and social interaction); and
5. Freedom from fear and distress (by providing conditions and treatment which avoid mental suffering).

The five freedoms model has evolved over the past three decades, reflecting our increased concern and understanding of animal welfare. This includes acknowledgment of non-human animal sentience and increased knowledge about the behavior, neuroscience and physiology of animals, gained via the growing field of animal welfare science (Duncan, 2006; Boissy et al., 2007; Proctor, 2012). Updated models recognize that animals should be biologically functional, should feel well, and lead reasonably natural lives (Fraser et al., 1997; Balcombe, 2009), and offer a way to systematically assess and manage animal welfare through five structured domains: Nutrition, Environment, Health, Behavior and Mental State (Mellor, 2014; Mellor and Beausoleil, 2015; Mellor, 2016). The Five Domains model assists the identification of internal physical and functional states and environmental conditions that cause subjective mental experiences (positive or negative affective states) relating to an animal’s welfare status (Mellor, 2017).

Increased understanding of the consequences of animal housing over the last twenty years has led to calls for improved provision for the welfare of animals housed in captivity, such as the use of enriching kennel management practices (Loveridge, 1998; de Jong et al., 2000; Bracke et al., 2006; Verga et al., 2007). Dogs held in kennel facilities in laboratory, shelter and training contexts have formed the basis for research evaluating various forms of enrichment of kennelled dog environments, such as provision of a more complex social, physical and sensory environment. Various elements of enrichment have been recognized as having a significant positive effect on the behavior, physiology and welfare state of dogs housed in kennel environments. These include exercise, intra- and inter-specific interaction, provision of toys and furniture, and olfactory, auditory and tactile stimulation (see (Wells, 2004) for review). It is unknown how successful these research findings have been in entering industry kennel management practices. The aim of this study was to evaluate how people perceive the importance of various kennel management practices relating to canine health, including kennel facility design and routine, intra- and inter-specific social interactions and environmental enrichment.

2. Material & Methods

2.1 Participants

We recruited 2,309 self-selected, adult participants via various social media platforms, web forums and email over a 15-week period. Every effort was made to recruit a diversity of participants, including those who did not own dogs or have experience working with dogs. Posts comprised a short call to action (such as “Short online survey re: dogs” or “Help scientists learn about people's attitudes regarding dog welfare & kennels. You don't need to like dogs to participate!”, from <https://twitter.com/dogsurvey>) and a hyperlink to the survey. Two hundred and seventy-three responses were discarded as unfinished; 2,036 complete responses were retained for analysis.

Most responses came from Australia (51.4%), the UK (12.9%) and the USA (11.3%). Responses received from New Zealand, Ireland, Canada, South Africa, Denmark, Norway, Germany, Spain and Finland accounted for a further 9.1% of participants, with the remaining 5.2% of participants coming from other countries. Some respondents (10.1%) chose not to disclose their home country. Respondents were 75.1% female, 16.2% male and 8.7% undisclosed, consistent with similar research in this field (Rohlf et al., 2010; Mornement et al., 2012). Participant age ranged from 18 to 84 years (mean = 37.4, *SD* = 12.7). Table 1 provides additional demographic information.

Table 1. Demographic details of survey participants (n = 2036)

Variable		Percentage
Gender	Female	75
	Male	16
	Undisclosed	9
Age (years)	18-29	29
	30-39	27
	40-49	18
	50-59	12
	60+	6
	Undisclosed	8
Highest level of education completed	Primary School	<1
	Part of Secondary School	3
	Completed Secondary School	20
	Vocational/TAFE/Trade School	13
	Undergraduate University Degree	31
	Postgraduate University Degree	22
	Undisclosed	10
Household income	Less than \$25,000	10
	\$25,001-\$50,000	13
	\$50,001-\$75,000	16
	\$75,001-\$100,000	16
	\$100,001-\$125,000	10
	\$125,001-\$150,000	7
	More than \$150,000	11
	Undisclosed	17
Number of adults in household	One	18
	Two	49
	Three	13
	Four	6
	Five or more	2
	Undisclosed	12
Number of children in household	Zero	69
	One	10
	Two	8
	Three	2
	Four or more	1
	Undisclosed	10
Household locality	City (Inner/Central Business District)	6
	Inner Suburbs	27
	Outer Suburbs	32
	Regional/rural town	13
	Regional/rural property	10
	Other	2
	Undisclosed	10

The majority of respondents (76%) currently owned a dog, whilst 40% had past or present employment or volunteer experience in a kennel facility. Table 2 provides additional employment information.

Table 2. Dog ownership and employment experience details of survey participants (n = 2036)

Variable		Percentage
Dog owner	No	24
	Yes	76
Previous or current employment in kennel facility	No	56
	Yes (detail below)	44
Type of experience (most recent role)	No experience	56
	Volunteer	18
	Animal Attendant	9
	Dog trainer	5
	Veterinary nurse	4
	Administrative	3
	Facility Manager or Owner	3
	Veterinarian	1
	Other	1
Type of experience (kennel facility)	Animal welfare shelter	30
	Commercial dog boarding	18
	Vet clinic	17
	Working dog	10
	Breeding	10
	Council pound	9
	Commercial training	3
	Greyhound racing	3
% Respondents who had experience in more than one type of kennel facility		24

2.2 Questionnaire

We employed a quantitative online survey of 70 items to examine the perceived importance of various kennel management practices and attitudes toward the role of enrichment in kennel facilities. The questionnaire was based on themes identified in the literature and in conjunction with consultation with industry specialists. Further discussion and pilot feedback from a focus group comprising veterinary, working dog kennel facility, dog trainer, animal behaviorist and psychologist experts aided refinement. Participants rated the importance of 36 different kennel management practices to the welfare of dogs housed in a kennel facility using a five-point Likert-style scale that varied from Extremely Unimportant to Extremely Important. Survey participants were instructed *‘This question asks how important you think different attributes of a kennel facility are to the welfare of dogs. The term welfare is used to refer to the animal's quality of life. If you are unsure, please rate to the best of your knowledge’*. All participants were asked to rate their agreement with 34 statements regarding enrichment activities and dogs housed in kennel facilities (17 items) using a five-point Likert-style scale that varied from Strongly Disagree to Strongly Agree. The final item of the questionnaire asked respondents to respond to the question *“What do you think is the most important consideration for the welfare of dogs housed in kennel facilities?”*. This item was included to evaluate if current models of animal welfare assessment developed by researchers include the features considered most important by industry practitioners and the general community. On occasions where more than one consideration was listed in response to this open-ended question and none identified as the most important, the first factor listed was taken to be the most important and used for subsequent analysis. Respondents rated their *own knowledge of dogs housed in kennels, compared to the average person*, and described their demographic features (16 items), including age, gender, country of residence, highest level of education attained, residence locality, household members and income, dog ownership and current or previous work experience relating to dog and kennel facility industries. A copy of

the questionnaire can be obtained from the corresponding author by request. The questionnaire and project were approved by the Monash University Human Research Ethics Committee (Project number: CF09/2370 – 2009001379).

2.3 Statistical analyses

Descriptive statistics were compiled for most data. Preliminary analysis showed that country of origin was not significant to ratings of importance or agreement, so data from all respondents were combined for the main analyses. Responses from the sections ‘perceived importance of kennel management practices’, and ‘agreement rating for statements regarding enrichment and dogs housed in kennel facilities’, were separately subjected to principle components analysis (PCA) to identify common patterns underlying the observed variation in attitudes. Suitability of the data for factor analysis was assessed prior to analysis. Direct Oblimin rotation was performed to aid interpretation, with the rotated solutions exhibiting the presence of a simple structure. Component scores were subsequently calculated using regression to create standardized subscale values reflecting the linear composite of the optimally weighted original variables. The six derived component subscales demonstrated good internal consistency reliability, with Cronbach’s alpha coefficients ranging between 0.70-0.88. The six derived component subscales were treated as new dependent variables and assigned names for ease of presentation. Multivariate analyses of variance were used to examine if attitudes toward kennel management practices and the perceived effect on the welfare of dogs housed in kennel facilities differed between various respondent experience (role and facility type) groups. A between groups multivariate analysis of variance was performed to investigate differences in age, employment role and gender for respondents with recent or current experience working in kennel facilities. The derived component subscales were used as dependent variables, with independent variable fixed factors of gender, age (grouped into five categories: 18-29; 30-39, 40-49, 50-59, 60+ years old) and most recent

kennel facility employment role. Preliminary assumption testing was conducted to determine normality, linearity, univariate and multivariate outliers, homogeneity of variance and multicollinearity. A Bonferroni probability adjustment (alpha level of 0.008) was used for all multiple comparisons.

The open-ended questionnaire item was subjected to thematic analysis with a semantic focus. Reading and re-reading all responses achieved familiarization with the data. Summarizing the first occurrence of each response using a semantic basis generated initial codes; subsequent responses listing a consideration already identified were assigned the same code. This phase generated an initial list of 68 unique coded considerations from 1544 responses. The analysis was informed by the theoretical frameworks of the Five Freedoms and Five Domains animal welfare models, and awareness of the perceived importance of kennel management practices attitude subscales derived following PCA (Braun and Clarke, 2006; Srivastava and Hopwood, 2009; Clarke and Braun, 2014). Codes were then assigned to themes on the basis of whether the identified considerations were related to dog, human, kennel management practices, facility design or external factors. Whether coded items aligned to physical, psychological, social or environmental concepts was also considered. Themes were then further reviewed against the Five Domains model and refined.

All statistical analyses were undertaken using the IBM SPSS Statistics 25 software package.

3. Results

3.1 Perceived importance of kennel management practices

PCA was run on the 36 items of the perceived importance of kennel management practices section of the questionnaire. Inspection of the correlation matrix showed many coefficients greater than 0.30. The Kaiser-Meyer-Olkin value was 0.91, exceeding the recommended value of 0.60; Bartlett's Test of Sphericity was statistically significant ($p < 0.001$), indicating the data was factorizable. Assessment of eigenvalues exceeding 1, scree plot and parallel analysis (as per Pallant 2007 and Laerd Statistics 2015) supported retention of three components following PCA. These components, which have been assigned names for ease of presentation, explained a total of 41.6% of the variance, with Component 1 (Enriched environment) contributing 25.7%, Component 2 (Health and hygiene) contributing 9.0%, and Component 3 (Limit social opportunities) contributing 6.9% of the variance respectively. Tables 3 shows the importance respondents rated each of the specific kennel management practices and component loadings derived from PCA. Items relating to the primary survival provisions of water, food and shelter were most commonly rated as 'Extremely important' to the welfare of dogs housed in kennel facilities, followed by access to medication for health care and a clean and hygienic environment. Exposure to enrichment items such as classical music, canine massage and lavender essence to smell were most frequently rated as unimportant or extremely unimportant to the welfare of dogs housed in kennel facilities.

Management practice	Extremely unimportant	Unimportant	Neither important or unimportant	Important	Extremely important	Rotated Component Coefficients		
						Enriched environment	Health and hygiene	Limit social opportunities
Access to clean water	0	0	0.4	6.1	93.5	-0.12	0.63	0.03
Feeding at least once daily	0	0	0.4	11.9	87.7	-0.12	0.64	0.03
Shelter from the elements (wind, rain, sun, etc.)	0	0.1	0.6	12.1	87.2	-0.03	0.64	0.05
Medication for health care		0.2	1.4	24.1	74.3	-0.04	0.65	-0.08
Clean and hygienic environment	0.1	0.1	1.0	25.2	73.6	0.05	0.58	0.18
Complete and balanced nutrition	0.1	0.2	1.5	25.4	72.8	-0.05	0.66	-0.06
Regular free-running exercise		0.2	2.2	25.4	72.2	-0.01	0.44	-0.37
Regular parasite control		0.1	1.6	29.5	68.7	-0.03	0.64	-0.09
Vaccinations ^	0.4	1.1	4.4	28.2	65.8			
Social contact with people	0.1	0.7	3.7	34.4	61.1	0.23	0.34	-0.15
Veterinary health checks	0.1	0.6	6.1	35.2	58.0	0.14	0.44	-0.13
Variety of daily activities	0.3	1.3	7.4	46.6	44.4	0.35	0.24	-0.27
Regular walks outside of the kennel facility	0.6	2.7	10.9	37.9	47.9	0.31	0.22	-0.22
Social contact with dogs	0.6	2.0	10.4	43.3	43.7	0.08	0.08	-0.79
Free access to be inside or outside ^	0.1	2.0	12.4	41.5	44.0			
Soft bedding (blankets)	0.2	2.2	11.9	44.8	40.9	0.36	0.42	0.11
Bedding raised above the ground	0.8	4.4	16.9	38.2	39.7	0.34	0.31	0.10
Playtime with other dogs	0.9	3.5	17.7	43.2	34.6	0.17	0.09	-0.76
Temperature controlled environment	0.5	3.7	19.4	42.3	34.1	0.42	0.35	0.20
Chew toys	0.5	3.5	16.6	49.9	29.6	0.44	0.19	-0.23
Visual contact with other dogs	0.9	3.5	21.7	42.7	31.2	0.13	0.10	-0.63
Predictable daily routine ^	0.9	5.7	22.8	47.2	23.2			
Grooming sessions	0.8	5.3	24.7	56.6	12.7	0.41	0.25	-0.02
Visual contact to outside of kennel facility	1.7	7.0	30.5	36.4	24.4	0.44	0.03	-0.18
Individual housing ^	0.9	7.0	30.2	42.2	19.7			
Training sessions	2.2	7.1	29.0	40.8	20.9	0.45	0.05	-0.27
Raw bones to chew ^	2.8	8.9	30.4	39.6	18.4			
Substrates to dig in	1.4	9.6	35.1	41.3	12.6	0.51	-0.01	-0.19
Ball toys	2.2	7.3	37.5	40.8	12.2	0.56	0.10	-0.14
Social housing with other dogs	3.6	10.1	39.6	36.1	10.6	0.25	-0.09	-0.64
Tug toys	2.6	8.6	45.1	35.4	8.3	0.54	0.04	-0.16
Access to water to swim	6.2	22.8	49.9	17.9	3.2	0.68	-0.10	-0.13
Recordings of human voices to listen to	12.3	24.5	46.9	13.5	2.8	0.75	-0.09	0.06
Relaxing music to listen to	14.2	25.4	41.6	15.4	3.4	0.75	-0.08	0.10
Canine massage	12.3	29.1	42.2	13.5	2.8	0.84	-0.10	-0.07
Lavender essence to smell	38.2	26.3	30.7	4.2	0.6	0.78	-0.17	0.06

Table 3. Perceived importance (%) of kennel management practices, and component loadings derived from principal components analysis.

^ Excluded from principal components analysis

3.2 Agreement with statements regarding enrichment activities and dogs housed in kennel facilities

The 34 items in the section of the questionnaire regarding enrichment activities and dogs housed in kennel facilities were subjected to PCA. The correlation matrix showed many coefficients greater than 0.30. The Kaiser-Meyer-Olkin value was 0.88; Bartlett's Test of Sphericity was statistically significant ($p < 0.001$), supporting factorability of the data. Assessment of the eigenvalues exceeding 1, scree plot and parallel analysis (as per (Pallant, 2013) and Laerd Statistics, 2015) supported retaining three components following PCA. These components explained a total of 38.8% of the variance, with Component 1 (Enrichment reduces performance) contributing 20.6%, Component 2 (Kennel facilities reduce canine welfare) contributing 11.7%, and Component 3 (Dog welfare is important) contributing 6.5% of the variance respectively. Table 4 shows the level of agreement rated by respondents for each of the statements regarding enrichment kennel management practices and dogs housed in kennel facilities, and component loadings derived from PCA. Statements supporting the use of enrichment to reduce stress and improve the welfare of dogs housed in kennel facilities were most commonly rated as 'Strongly agree'. Statements suggesting that dogs experiencing stress or that withholding enriching kennel management practices is useful to the training or performance of working dogs housed in kennel facilities were most frequently rated as 'Strongly disagree'.

Statement	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree	Rotated component coefficients		
						Enrichment reduces performance	Kennel Facilities Reduce Canine Welfare	Dog welfare is important
Lowering the stress experienced by dogs living in kennel facilities is good for their welfare *	0.4	0.6	4.6	35.5	58.9	0.49	-0.28	-0.25
Dogs housed in kennel facilities should have daily access to enrichment activities *	0.4	1.0	5.5	36.1	57.0	0.53	-0.35	-0.15
Enrichment activities help lower stress levels of dogs in kennel facilities *	0.2	0.6	6.4	38.4	54.4	0.59	0.27	0.22
Dogs in kennels are more relaxed when they have access to enrichment activities	0.3	0.9	7.9	46.2	44.7	-0.48	0.26	0.24
The way that kennel facilities are operated is directly related to the welfare of dogs housed there ^	1.6	3.9	14.1	36.9	43.5			
It's important that dogs housed in kennel facilities can see what is going on around them ^	0.7	2.6	17.2	54.7	24.9			
Dogs get stressed when they first come into kennel facilities	0.6	2.5	19.4	54.3	23.2	-0.12	0.58	0.11
Dog welfare is very important to the people who directly care for dogs in kennel facilities (Animal attendants)	0.7	3.7	23.3	48.7	23.6	0.02	-0.11	0.71
Dog welfare is very important to the people who directly train dogs in kennel facilities (Dog trainers)	0.7	4.2	25.9	49.3	19.9	0.06	-0.16	0.75
Dog welfare is very important to the general public community	2.4	14.1	22.4	47.1	14.0	0.07	0.00	0.45
Dogs shouldn't be housed in kennel facilities for more than six months at a time	2.9	13.8	33.4	31.1	18.8	0.05	0.78	-0.05
Some working dogs fail in their training because they get too stressed being housed in kennel facilities	1.4	8.0	44.2	37.4	9.0	-0.22	0.46	0.02
Working dogs that are kept in kennel facilities receive regular veterinary care	1.0	6.8	45.2	36.8	10.2	0.04	-0.28	0.58
Lower stress levels in dogs housed in kennel facilities mean that more dogs can be successfully trained as working dogs	3.3	9.7	38.3	35.0	13.7	-0.08	0.15	0.29
Dogs housed in kennel facilities are not as well looked after as dogs kept at home	6.8	23.0	35.5	26.7	8.0	0.12	0.62	-0.25
Working dogs housed in kennel facilities for long periods are well looked after	3.1	19.8	51.0	21.3	4.8	0.07	-0.44	0.50
Playing classical music helps dogs to relax in kennel facilities ^	7.8	12.2	61.2	15.3	3.5			
Dogs that get stressed in kennel facilities during training shouldn't be placed as working dogs	5.2	25.2	46.8	18.8	4.0	0.23	0.13	0.10
Spraying the facility surfaces with lavender essential oil helps dogs to relax in kennel facilities ^	8.8	15.2	68.2	7.0	0.8			
Dogs housed in kennel facilities prefer to spend time with other dogs rather than people ^	3.8	30.1	58.8	6.9	0.5			
Dogs should not be housed in kennel facilities *	9.6	36.5	37.9	12.8	3.2	-0.06	-0.67	0.19
Dogs housed in kennel facilities enjoy being with people more than other dogs ^	7.3	33.0	51.8	6.5	1.3			
Dogs can live in kennel facilities happily for over five years	22.6	27.1	32.1	16.7	1.5	0.02	-0.71	0.09
Dogs housed in kennel facilities are easier to train than those housed in home environments	12.9	37.3	42.7	6.7	0.4	0.41	-0.21	0.20
Dogs shouldn't be housed socially (in groups) because it's dangerous	16.1	40.4	30.9	9.8	2.8	0.31	0.21	0.06
Dogs in training will perform better without any access to enrichment activities while housed in kennel facilities	28.6	40.8	22.4	6.2	2.0	0.60	-0.05	0.01
Providing enrichment activities to working dogs in training kennel facilities distracts them from their training tasks	26.0	50.6	18.9	3.9	0.6	0.72	0.02	0.06
Enrichment activities hide behaviors of unsuitable working dogs until later in the training process	29.8	41.2	27.0	1.7	0.3	0.71	0.10	0.00
All kennel facilities are the same from the dogs' point of view	41.5	36.3	15.6	4.6	2.0	0.46	0.14	-0.01
Dogs who have access to enrichment activities are more stressed than those who don't	38.8	45.0	12.3	2.3	1.6	0.61	-0.05	0.01
A dog's trainer should be the only source of positive attention and interaction	39.5	45.0	10.0	3.7	1.7	0.53	-0.35	-0.15
Dogs training to be working dogs should not have access to enrichment activities in kennel facilities because it masks their natural behavior	41.7	42.0	14.4	0.9	1.1	0.72	0.02	0.06
Stress helps to get the best performance from a working dog.	59.4	31.8	7.5	0.7	0.5	0.50	-0.04	-0.01
Dogs housed in kennel facilities don't need to have regular veterinary checks ^	68.4	24.5	4.7	1.1	1.3			

Table 4. Rated agreement (%) with statements about enrichment and dogs in kennel facilities, component loadings and summary statistics for components derived from principal components analysis.

* Item reverse scored prior to principal components analysis

^ Excluded from principal components analysis, due to communality <0.20

3.3 Differences in attitudes toward kennel management practices and their perceived importance for the welfare of dogs housed in kennel facilities

3.3.1 Differences between respondents with and without kennel industry experience

There was a statistically significant difference on the combined dependent variables between people who volunteered at kennel facilities, those in paid employment roles in kennel facilities and those with no direct volunteer or employment experience with kennel facilities, $F_{(5,1873)} = 17.04$, $p = <0.001$; Pillai's Trace = 0.10; partial eta squared = 0.05. When the results for the dependent variables were considered separately, the only variable not to reach statistical significance was Hygiene and Health (see Table 5). Statistically significant differences were found for Enriched Kennel Environment, $F_{(2,2029)} = 7.96$, $p = <0.001$, partial eta squared = 0.01, where volunteers were significantly different from paid employees and those with no experience; Limit social opportunities, $F_{(2,2029)} = 7.44$, $p = 0.001$, partial eta squared = 0.01, where those in paid employee roles were significantly different from volunteers and those with no experience; Enrichment reduces performance, $F_{(2,1872)} = 42.09$, $p = <0.001$, partial eta squared = 0.04, where people with no industry experience were significantly different from volunteers and paid employees; Kennel facilities reduce canine welfare, $F_{(2,1872)} = 14.66$, $p = <0.001$, partial eta squared = 0.02, where volunteers were significantly different from employees and those with no experience; Dog welfare is important, where those in non-voluntary employment were significantly higher than volunteers or people with no kennel facility employment experience, $F_{(2,1872)} = 20.58$, $p = <0.001$, partial eta squared = 0.02.

Dependent variable	Paid Employees	Volunteers	No Industry Experience	p-value
Enriched kennel environment	-0.02	0.19*	-0.05	<0.001
Health and hygiene	-0.02	0.14	-0.04	0.011
Limit social opportunities	0.14*	-0.05	-0.05	0.001
Enrichment reduces performance	-0.21	-0.26	0.18*	<0.001
Kennel facilities reduce dog welfare	-0.19*	0.17	0.04	<0.001
Dog welfare is important	0.24*	-0.03	-0.10	<0.001
Self-rated knowledge of dogs housed in kennel facilities	4.45*	3.99*	3.17*	<0.001
The welfare of dogs is very important to me	4.70	4.75	4.62	0.010

Table 5. Means on the derived component subscale dependent variables, self-rated knowledge about kennel facilities and agreement with the statement '*The welfare of dogs is very important to me*', comparing groups with different kinds of kennel facility experience.

* indicates group significantly differs from the others

People whose most recent role in a kennel facility was volunteering were most likely to support an enriched kennel environment, although the effect size was very small. Beliefs regarding the importance of *Health and hygiene* were similar between volunteers, paid employees and those without direct experience in a kennel facility. Paid employees were most likely to support limiting social opportunities for dogs housed in kennel facilities. Respondents without any direct experience with kennel facilities were most likely to support attitudes that enrichment activities will negatively impact training and work performance of dogs housed in kennel facilities. People who work in kennel facilities were least supportive of the attitudes suggesting kennel facilities reduce dog welfare, and most supportive of statements that the welfare of dogs is very important when compared to the views of volunteers and those without direct kennel facility experience. All statistically significant differences for these items showed only small effect size.

Self-rated knowledge of dogs housed in kennel facilities reflected significant differences with large effect size between all three categories, $F_{(2,2104)} = 42.09$, $p = <0.001$, partial eta squared = 0.39. Paid employees had the highest mean self-rated knowledge (rated Very high),

followed by volunteers (High), and those without direct experience (Neither high or low, compared to the average person). All three groups strongly agreed that the welfare of dogs is very important to them.

3.3.2 Differences between kennel facility roles

We refined our focus to examine only the attitudes of those engaged in non-voluntary employment roles in kennel facilities. A one-way multivariate ANOVA revealed a statistically significant difference on the derived dependent variables between people engaged in different employment roles within kennel facilities, $F_{(4,1760)} = 3.16$, $p = <0.001$; Pillai's Trace = 0.17; partial eta squared = 0.04. When the results for the dependent variables were considered separately, the only variable to reach statistical significance was Kennel Facilities Reduce Canine Welfare, $F_{(4,1760)} = 7.68$, $p = <0.001$; partial eta squared = 0.06, indicating medium effect size (refer Table 6). Veterinary nurses and Animal attendants were most likely to agree with attitudes suggesting that kennel facilities are detrimental to the welfare of dogs while Kennel facility managers and owners were least likely to support this viewpoint.

Table 6. Means on the derived component subscale dependent variables, self-rated knowledge about kennel facilities and agreement with the statement '*The welfare of dogs is very important to me*', comparing different kennel facility employee groups.

Dependent variable	Animal attendants	Veterinary nurses	Dog trainers	Veterinarians	Facility Managers & Owners	p-value
Enriched kennel environment	-0.05	-0.17	0.10	-0.42	0.62	0.09
Health and hygiene	0.04	0.23	-0.09	-0.32	-0.23	0.01
Limit social opportunities	0.23	0.36	-0.01	-0.06	0.01	0.08
Enrichment reduces performance	-0.20	-0.18	-0.33	-0.03	-0.14	0.57
Kennel facilities reduce dog welfare	-0.06*	0.07*	-0.39	-0.62	-0.77	<0.001
Dog welfare is important	0.06	0.13	0.44	0.18	0.47	0.01
Self-rated knowledge of dogs housed in kennel facilities	4.41	4.24*	4.55	4.61	4.63	<0.001
The welfare of dogs is very important to me	4.75	4.80	4.80	4.32	4.54	0.02

Self-rated knowledge of dogs housed in kennel facilities reflected significant differences with moderate effect size between all five categories, $F_{(4,472)} = 5.89$, $p = <0.001$, partial eta squared = 0.05. Facility managers and owners and Veterinarians had the highest mean self-rated knowledge, followed by dog trainers, animal attendants, and veterinary nurses. All five groups strongly agreed that the welfare of dogs is very important to them.

3.3.3 Differences between industry sector kennel facility types

Examination of the responses from non-voluntary employees with experience working in just one type of kennel facility using a one-way multivariate ANOVA showed significant differences between industry sectors, $F_{(36,2430)} = 4.62$, $p = <0.001$; Pillai's Trace = 0.39; partial eta squared = 0.07, indicating medium effect size. When considered separately, all

dependent variables except for Health and Hygiene exhibited significant differences (see Table 7).

Respondents whose work experience was limited to Shelter kennel facilities were more likely to be supportive of enriched kennel environments than those working in Commercial Boarding, Veterinary Clinic and Greyhound Racing kennel facilities, $F_{(7,446)} = 4.03$, $p = 0.001$; partial eta squared = 0.05. Commercial Boarding kennel facility employees were significantly more likely to support limiting social opportunities for dogs housed in kennels than those from other industry sectors, $F_{(7,446)} = 3.98$, $p = 0.001$; partial eta squared = 0.05. Attitudes supporting the idea that enrichment activities will reduce dogs' performance in training and work tasks were significantly more likely to be held by people whose work experience was limited to Greyhound Racing and Working Dog kennel facilities, $F_{(7,446)} = 3.67$, $p = 0.001$; partial eta squared = 0.05. Respondents who worked in Commercial Breeding, Greyhound Racing and Working Dog kennel facilities were significantly more likely to disagree with attitudes suggesting kennel facilities reduce dog welfare than other industry sectors, $F_{(7,406)} = 13.59$, $p = <0.001$; partial eta squared = 0.17, exhibiting large effect size. Those people whose experience was limited to Working Dog kennel facilities were significantly more likely to agree with attitudes supporting that dog welfare is important compared to all other groups, $F_{(7,406)} = 6.64$, $p = <0.001$; partial eta squared = 0.09.

Table 7. Means on the derived component subscale dependent variables comparing different industry sector kennel facility type groups for non-voluntary employees who have only worked in one facility type. * significant $p = <0.008$

Dependent variable	Commercial Boarding	Shelter	Council Pound	Veterinary Clinic	Commercial Breeding	Commercial Training	Greyhound Racing	Working Dog	<i>p</i> -value
Enriched kennel environment	-0.30	0.29*	0.24	-0.24	0.07	-0.08	-0.37	-0.10	0.001
Health and hygiene	-0.04	0.19	0.08	0.01	-0.12	-0.05	-0.39	-0.17	0.148
Limit social opportunities	0.65*	-0.06	-0.12	0.06	-0.26	0.25	-0.01	-0.14	0.001
Enrichment reduces performance	-0.01	-0.31	-0.10	0.08	-0.39	-0.20	0.37*	0.19*	0.001
Kennel facilities reduce dog welfare	0.03	0.36	0.59	0.31	-0.74*	-0.47	-1.25*	-0.76*	<0.001
Dog welfare is important	0.17	0.11	-0.51	0.01	0.02	0.37	0.24	0.88*	<0.001

3.3.4 Effects of gender, age and kennel facility role

There was a statistically significant difference between age groups on the combined dependent variables, $F_{(24,1600)} = 1.92$, $p = 0.005$; Pillai's Trace = 0.11. When the results for the dependent variables were considered separately, significant differences were identified for Health and hygiene ($F_{(4,402)} = 13.79$, $p = 0.005$; partial eta squared = 0.04) and Enrichment reduces performance ($F_{(4,402)} = 12.98$, $p = 0.007$; partial eta squared = 0.03). Follow up univariate analyses showed that employees under the age of 30 years were significantly more likely to support the importance of health and hygiene items than older respondents, $F_{(4,990)} = 6.25$, $p = <0.001$; partial eta squared = 0.02. Employees over the age of 50 years were significantly more likely to support attitudes suggesting that enrichment activities will reduce dogs' performance in training and work tasks than their younger colleagues, $F_{(4,916)} = 5.39$, $p = <0.001$; partial eta squared = 0.02.

Further investigation revealed a significant association also existed between age and employee role, $\chi^2 (16, n = 484) = 66.78$, Cramer's V = 0.186. Over three quarters of people employed in kennel facilities aged 18-29 were engaged in animal attendant or veterinary nurse roles, with a further 18% employed as dog trainers. Facility managers and owners were mostly (>95%) aged over 30 years, with 65% being 40 years and older. Similarly, most veterinarians were over 40 years of age, although close to 40% were younger than 40 years.

Independent-samples t-tests revealed statistically significant differences between males and females on all but two of the derived dependent variables. Males were less likely to rate an enriched kennel environment as important than females, $t (2032) = -9.69$, $p < 0.001$ (two-tailed), eta squared = 0.04. Females were more likely to rate Health and Hygiene as important than males $t (2032) = -10.33$, $p < 0.001$ (two-tailed), eta squared = 0.05. Males were more supportive of attitudes that enrichment reduces training and work performance of dogs

housed in kennels than females, $t(1875) = 9.63$, $p < 0.001$ (two-tailed), eta squared = 0.06. Females were more likely to agree that kennel facilities reduce dog welfare than males, $t(1875) = -7.97$, $p < 0.001$ (two-tailed), eta squared = 0.03, and showed a higher mean agreement with the statement “*The welfare of dogs is very important to me*” than males, $t(2109) = -6.05$, $p < 0.001$ (two-tailed), eta squared = 0.02. The effect size of these differences ranged from small to medium. There was no significant difference in the age groups of males (mean age = 39.01, SE = 0.67) and females (mean age: 37.09, SE = 0.30).

Table 8. Means on the derived component subscale dependent variables, self-rated knowledge about kennel facilities and agreement with the statement ‘*The welfare of dogs is very important to me*’, comparing Males and Females.

Dependent variable	Males	Females	<i>p</i> -value
Enriched kennel environment	-0.46	0.10	<0.001
Health and hygiene	-0.56	0.12	<0.001
Limit social opportunities	0.06	-0.01	0.235
Enrichment reduces performance	0.51	-0.11	<0.001
Kennel facilities reduce dog welfare	-0.40	0.08	<0.001
Dog welfare is important	0.06	-0.01	0.215
Self-rated knowledge of dogs housed in kennel facilities	3.57	3.66	0.090
The welfare of dogs is very important to me	4.41	4.72	<0.001

A Chi-square test for independence indicated a significant association between employee role and gender, $\chi^2 (4, n = 484) = 28.09$, Cramer's $V = 0.241$. Of the people who completed our questionnaire, a higher proportion of males were found in dog training, kennel facility management or ownership roles than females, and three times as likely to be the kennel facility veterinarian. Females were nearly twice as represented in animal attendant roles, and three times more prevalent than males in veterinary nursing roles.

Employee category	Males	Females
Animal Attendant	25%	41%
Veterinary Nurses	6%	20%
Dog Trainers	35%	22%
Veterinarians	12%	4%
Kennel Facility Managers/Owners	22%	13%

Table 9. Frequency (%) of male and female respondents in kennel facility employee categories.

3.4 Beliefs about the most important consideration for the welfare of dogs housed in kennel facilities

The open-ended question was not compulsory and was completed by 1559 participants. Following iterative qualitative thematic analysis with a semantic focus (refer Appendix 1), we mapped 75% of responses directly across four of the Five Domains identified by Mellor (2017), namely Nutrition (6%), Environment (9%), Health (20%), and Behavior (40%). Some responses referred to the Five Freedoms model directly, or attributed the most important thing as being the combination of physical and mental wellbeing. Certain respondents focused on aspects of basic survival through nutrition and shelter (food, clean water, shelter), while others felt that social opportunities (with dogs, people or both) or veterinary care (vaccinations, disease and parasite control, regular health checks) was most important. Natural living opportunities outside of the kennel facility (off leash exercise, access to grass, opportunities to sniff trees and animals) were mentioned in several responses. Enrichment opportunities (provision of toys, opportunities to chew, playing with dogs or people) featured in some responses, and kennel facility staffing aspects (appropriately trained staff, staff to dog ratios) were included.

Of the responses that were unable to be directly mapped to the Five Domains model, the overarching theme was Human-Dog Interaction, including items that are produced as direct consequences of interaction. This was conveyed in terms of direct practices (touch the dogs, speak to the dogs, constant human supervision) but also in conceptual terms that highlight the importance of attachment, kinship and method of interactions (treating each dog as an individual; that the dog feels loved, safe or secure; that the dog is shown respect and understanding; that the dog has the freedom of choice to react how it wants). In some cases, responses were in direct opposition with the viewpoints of other respondents (treat the dog like a dog, not a person; recreate how a person would like to live), and showed evidence of

different approaches to dog training and handling (non-coercive positive reinforcement; leadership and discipline, pack mentality; awareness of being part of a pack). Regulation of kennel facilities was mentioned (better government regulation and policing inspections), as was facility design (evidence based ethological approach to kennel facility design).

4. Discussion

The welfare of kenneled dogs can be understood as reflecting the interplay between human attitudes and behaviors, the physical environment and facility management practices, and the resident dogs. New research has shown that the perceived welfare of dogs housed in kennel facilities can vary based on context (Cobb et al, in press). For example, although dogs in both roles spend a large proportion of their lives living in kennel facilities, racing greyhounds are perceived to have low welfare while drug detection dogs are perceived to have high welfare. This difference in perception may be related to the people interacting with the dogs. Research examining animal welfare in zoos has attributed different welfare outcomes from similar facilities operated under the same requirements to the actions of zoo animal care staff (Cole and Fraser, 2018). For example, research has shown that where zoo animal have positive relationships with zoo personnel, their stress in response to the presence of zoo visitors decreased and indicators for positive welfare increased (Cole and Fraser, 2018). While research efforts have explored optimal kennel design (Hubrecht et al., 1992; Hubrecht, 1995) and responses of dogs to living in the kennel environment (Hennessy et al., 1997; Beerda et al., 1999a; Beerda et al., 1999b; Hiby et al., 2006; Rooney et al., 2007a; Pullen et al., 2012; Dalla Villa et al., 2013; Sandri et al., 2015), the attitudes of humans providing care to dogs housed in kennel facilities are new to examination.

4.1. Attitudes that underlie care-giving behavior vary

What people believe is important will influence their behavior, directly impacting on the care given to animals under their responsibility. This exploratory study found great variety in the perceived importance of kennel management practices relating to canine health, kennel facility design and routine, intra- and inter-specific social interactions and environmental enrichment. Although there is general consensus as to what is most important to the welfare of dogs housed in kennel facilities, attitudes toward kennel facilities and their impact on canine welfare vary across different industry sectors, between kennel industry roles and with individual respondent features such as age and gender. Priority was given to survival (food, water and shelter) and physical health needs (veterinary medication, parasite control and vaccinations), with social and enrichment activities attracting ratings of less perceived importance.

The qualitative thematic analysis item yielded a greater emphasis on the importance of behaviour to the welfare of dogs housed in kennel facilities than was reflected in the quantitative survey questions. This highlights the importance of a mixed-method approach to improved understanding of attitudes toward animal behaviour. A future investigation that uses a qualitative interview approach could further elucidate the differences in attitudes that underlie care-giving behaviour.

This study has demonstrated that the perceived importance of kennel management practices and attitudes vary between employee roles, such as primary care giving staff (animal attendants and vet nurses) and kennel facility managers and owners. If individuals believe a certain management practice is unimportant, they may be less likely to do it. Conversely, if their manager or the facility manager believes something is unimportant that they believe is of high value to the welfare of dogs in their care, being prevented from providing that activity

or item may impact on employment satisfaction. These belief differences may contribute to workplace conflict, occupational stress and job dissatisfaction, which could result in increased employee turnover in primary care giving roles (Rohlf, 2018) and reduced canine welfare. In extreme cases, where direct care employees are prevented from engaging in practices they believe to be of high value to the welfare of dogs, people may experience compassion fatigue, burnout and moral distress (Foster & Maples 2014; Lloyd & Campion 2017; Rohlf 2018). Similar effects have been observed and are well documented in hospital contexts where nursing staff are limited in their capacity to act, even when experienced and highly trained, by protocols deferring patient care decision making to doctors or hospital management guidelines (Burston & Tuckett 2012; Varcoe et al 2012; Lu et al 2012; Oh & Gastmans 2013; Austin et al 2017).

People working in different jobs may prioritise different management practices as a reflection of their training and normative beliefs consistent with their industry's culture. For example, the different attitudes exhibited toward the importance of enrichment opportunities for dogs housed in kennels between Greyhound Racing and Shelter kennel facility employees may reflect the variation in kennel workers' education or training about providing for the welfare of dogs housed in kennels. However, attitudes may also be influenced by the functional category of the animal (considering the animal as a companion or pet, or as a means for profit) and acknowledgement of (or detachment from recognizing) the dogs under their care as animals capable of emotions (Taylor & Signal 2009; Beausoleil et al 2018; Wilkins et al 2015; Groizard 2019). Recognition that dogs have feelings which can be described in similar terms to human emotions (e.g. fear, panic, pleasure of seeking novelty, play, per Panksepp 1998) is still gaining acceptance, but may result in subsequent prioritization of activities that promote not just physical fitness, but also mental health of non-human animals (Grandin 2018). There is a growing body of research identifying the performance benefits in dogs

when people reduce negative emotional experiences for dogs (such as fear in training), and promote positive canine welfare experiences (Hiby et al., 2004; Gaines et al., 2008; Rooney et al., 2009; Rooney and Cowan, 2011; Deldalle and Gaunet, 2014; Rooney et al., 2016; Ziv, 2017). Differences across industry sectors highlight the value that guidance for care provision at a regulatory legislation level can offer.

4.2. Does regulation offer evidence-based standards of care to working dogs housed in kennel facilities?

Despite the widespread use of working dogs, legislation protecting their welfare is inconsistent and limited. Legislative requirements for provisions to working and sporting dogs housed in kennel facilities are often limited to minimum recommended standards and practices that are not directly enforceable and inconsistently applied. For example in Australia, recommended codes of practice, or standards and guidelines, relating to the operation of kennel facilities exist in some, but not all states and territories. As animal welfare is managed at a state level within Australia, Commonwealth entities such as the military, border force (customs), biosecurity and police lie outside of state and territory jurisdiction (e.g. in the state of New South Wales, the Prevention of Cruelty to Animals Act 1979 does not apply to the handling and use of police or corrective services drug detection dogs). Guide or seeing-eye dog organizations may be exempt from state regulations if they are members of an international industry-elected body, such as the International Guide Dog Federation, that has its own standards and member auditing process (e.g. in the state of Victoria, Guide Dog or Seeing Eye Dog organizations are exempt if members of the IGDF). The application of regulations to various sporting and working dog sectors can also be inconsistent. In the state of Queensland, Australia, livestock herding farm dogs are exempt

from state dog breeding and animal welfare standards and registration, but dogs used for hunting are not (QLD State Government, 2008). In many cases, working and sporting dogs are housed in kennel facilities out of public view on private properties, adding to the challenge of policing regulations even when they do apply. In the United Kingdom, working dog groups such as military, police, hunting and guide dogs are exempt from legislation which applies to the operation of companion dog boarding, breeding or training kennel facilities as they are considered to be non-commercial enterprises (Dept for Environment, Food and Rural Affairs, 2018). The physical, mental and social needs of dogs for health and wellbeing are consistent across industry sectors. Regulatory requirements should reflect this; outlining minimum standards of care and suggested best practice to enable optimal welfare for dogs housed in kennel facilities, with accountability and without exemption.

The differences in perceived importance of specific kennel management practices and their relation to canine welfare between the general public and industry practitioners highlight opportunities for the industry to raise public awareness and also be informed of public expectations. Respondents with no experience volunteering or working in kennel facilities were least likely to support attitudes suggesting that kennels reduce the welfare of dogs, yet rated the welfare of dogs as being very important to them. That non-voluntary staff, and particularly primary care staff such as animal attendants and veterinary nurses were most likely to agree that kennel facilities reduce the welfare of dogs may reflect their own observations and experiences. It is likely that primary care staff working in shelters where most dogs are displaced from their regular environment for short to medium terms would make different conclusions about the impact of kennel facilities when compared to people working with a stable population of dogs living full time in kennel facilities for long term periods, such as those in racing greyhound or working dog kennel facilities. These views may also be a reflection of industry sector normative beliefs.

4.3. Expanding models of animal welfare assessment to reflect the impact of humans

Dogs are different to many other animals in that they appear to enjoy interacting with humans, perhaps due to a long period of co-domestication (Payne et al., 2015; Udell and Brubaker, 2016). For many animals, their welfare is better if interactions with humans can be limited, or avoided entirely. The opposite seems to apply to dogs, provided the interactions with people are appropriate, they can be very enriching (Hubrecht et al., 1995; McGreevy et al., 2005). The contribution of human-animal interaction is not included as a direct consideration within the Five Domains model of animal welfare assessment. However, studies focused on handlers of livestock have shown the importance of human caretaker attitudes, including their relationship to handler behaviors toward animals in professional facility settings (Hemsworth et al., 1994; Coleman et al., 2000; Coleman et al., 2003). Recent research examining zoos and zoo keepers has proposed that there is a “human dimension” to animal welfare comprising seven key components, including items which exhibit resonance with this study’s findings, such as: treating animals as individuals; the attitudes of keepers; the keepers’ knowledge and experience; the keepers’ own well-being; and the influence of facility design on how keepers and others interact with the animals (Cole and Fraser, 2018). These consistent themes across livestock production, zoo and now kennel contexts strongly suggest that the element of human-animal interaction is an integral component to the welfare of animals kept in captivity under human management and should therefore be included in future models of animal welfare assessment.

4.4. Training and education

Exploring the perceived importance of kennel management practices has enabled assessment of how successfully the emerging research evidence base is entering and informing industry practice. The use of lavender as olfactory stimulation and music as auditory enrichment were

rated as two of the most unimportant of kennel management practices, yet there are numerous scientific studies suggesting they can be helpful in reducing stress experienced by dogs housed in kennel facilities (Wells et al., 2002; Graham et al., 2005)(Wells et al 2002; Graham et al 2005; Kogan et al 2012; Bernandini & Niccolini 2015; Bowan et al 2015; Bowman et al 2017; Binks et al 2018; Köster et al 2019). This suggests that dissemination of research findings is not always succeeding to industry practice uptake. This may be due to communication of research being limited to peer-reviewed journals that may be inaccessible without journal subscription access, or because manuscripts are written in a manner not easily interpreted by lay people (Cobb & Hecht 2016). Opportunities to share the emerging evidence base and industry best practice between the working and sporting dog industry sectors are limited (Branson et al 2012). In competitive contexts like greyhound racing, motivation for participants to share what optimizes dog wellbeing and performance to other competitors in the same industry sector may not be seen as beneficial (Cobb et al, 2015). These results highlight the importance for scientists exploring how to optimize kennel facility environments for canine wellbeing to engage in active outreach with industry and community networks to share their research findings. Communicating science in ethically charged areas such as animal welfare can be difficult (Cawkwell and Oshinsky, 2016; Lewandowsky and Oberauer, 2016; van der Linden et al., 2017). Outreach will be most effective when viewed as a respectful and engaged two-way process rather than relying on the deficit model of communication that is the default style traditionally used by scientists in public engagement (Varner, 2014; Simis et al., 2016).

4.5. Conclusion

The results of this study are the first to reveal the perceived importance of specific kennel management practices and how attitudes vary across kennel facility industry roles and sectors. We have identified areas where differences in attitudes exist and may be contributing

to occupational stress and staff turnover. The introduction of consistent regulatory standards to which kennel facility operators are held accountable, without exemption, would appear to offer a way to clarify what dogs need to live a good life while housed in kennel facilities, both physically and mentally. Human-animal interactions, including attitudes that directly influence care-giving behavior, clearly impact the welfare of animals and should be included in future models of animal welfare assessment. Finally, our results suggest that researchers studying best practice in welfare and kennel enrichment activities need to be more engaged in meaningful outreach with industry stakeholders to ensure their findings penetrate into evidence-based industry practice to advance the welfare of dogs housed in kennel facilities.

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Chapter 5

Physiological responses of young working dogs entering training kennels from puppy raising homes: a pilot study.

Mia L Cobb^{*a}, Adrian Carter^a, Alan Lill^b & Pauleen C Bennett^c

^a Turner Institute of Brain and Mental Health and the School of Psychological Sciences
Building 17, Clayton Campus, Wellington Rd, Monash University
Victoria, Australia, 3800

^b Department of Ecology, Environment and Evolution, School of Life Sciences,
Melbourne Campus, La Trobe University,
Victoria, Australia, 3086

^c School of Psychology and Public Health
Bendigo Campus, LaTrobe University, P.O. Box 199, Bendigo
Victoria, Australia, 3552

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Abstract

Concerns have been raised about the potential impact of different kinds of housing on animal welfare, including for kennelled working dogs. This research determined the effect of entering a kennel facility on the stress physiology of young working dogs. Salivary cortisol and immunoglobulin A levels, and blood neutrophil:lymphocyte ratios were obtained for twenty dogs in their puppy-raising foster homes two weeks before arriving at training kennels, and two and sixteen days after arrival in the kennel facility. These results were compared to a group of ten dogs that were sampled on a comparable sampling schedule while they remained in residential foster homes. Salivary cortisol showed a significant increase in dogs entering kennels ($p < 0.05$) compared to those that remained in their puppy-raising homes and this increase continued for 16 days ($p < 0.05$). Dogs entering kennels exhibited a significant decrease ($p < 0.05$) in salivary IgA, although the baseline means differed between the two groups. Neutrophil:lymphocyte ratios exhibited a significant increase ($p < 0.05$) in dogs entering kennels, with this returning to baseline levels after two weeks. These results show that young working dogs demonstrate an acute stress response when transitioning from puppy-raising foster homes into a training kennel facility. The timeframe and nature of this stress response are relevant to the assessment of young dogs' suitability to commence training for working roles.

Keywords:

dog; kennel; physiology; stress; welfare; working dog;

cortisol; immunoglobulin, neutrophil:lymphocyte ratio

Highlights:

- We measured three physiological stress variables in dogs over 30 days, demonstrating that young working dogs find the transition from their puppy-raising home into training kennel facility to be stressful.
- Dogs that remained in a foster puppy-raising home environment did not exhibit significant changes in salivary cortisol, salivary immunoglobulin A or the blood neutrophil:lymphocyte ratio, whereas these variables changed in dogs upon entering training kennels.
- Stress experienced during the transition from puppy-raising home to living in the training kennel facility may influence the welfare and performance outcomes of working dogs.

1. Introduction

Growing awareness of the implications of different types of animal use to the welfare of animals has increased public expectations about conditions for animals kept in captivity [1]. Recently this has led to calls for improved provision for the welfare of animals housed in captivity, including kennelled dogs [2]. Domestic dogs play significant roles in the lives of many people globally as companions. They also perform valuable duties in many societies as assistance, detection and security aids, as well as providing entertainment in the racing and performance industries. A large proportion of working dogs, as well as dogs kept primarily to breed animal companions, are housed in kennel environments for periods ranging from weeks to years. Kennel facility design typically prioritises easy hygiene maintenance and the

number of animals that can be housed safely in a limited amount of space. Consequently, kennel facilities are often considered to be sterile and unable to fulfil dogs' behavioural needs [3].

Neuroendocrine responses are routinely used to quantify an animal's response to stress, generally measured by changes to the functioning of the Hypothalamus-Pituitary-Adrenal (HPA) axis [9]. Cortisol is the primary glucocorticosteroid hormone in humans and most mammals; it is produced in the adrenal gland and controlled directly by the release of the pituitary gland peptide, adrenocorticotrophic hormone. Cortisol is involved in responses to stress, increasing blood pressure and blood sugar concentration, and decreasing immune responses [9]. Cortisol has been used as an indicator of physiological change in response to acute stress across many mammal species, including humans, pigs, rats, mice, and dogs in shelter, laboratory and kennel environments [10-12]. Within these studies, measured change within an individual has widely been considered representative of welfare.

As part of HPA axis activity, cortisol typically exhibits elevated levels when dogs experience a state of acute stress. This was demonstrated by Hennessy and colleagues when dogs entered a county animal shelter kennel environment and their plasma cortisol response was tracked over the course of their stay [13]. A significantly elevated level of plasma cortisol was documented in the dogs on their first, second or third day in the shelter, compared to the level in dogs that were in the shelter for two weeks. Whilst plasma cortisol has been used to assess stress in many human and animal studies [14-18], blood sampling from animals for stress-related research could be a confounding factor in itself. The physical restraint of animals required for

adequate blood collection and the act of venepuncture can act as additional stressors to the animal. Salivary sampling is the preferred method of cortisol collection for animal welfare research and provides a way of interpreting domestic dog HPA axis activity in response to acute and chronic stressors [19-24].

Salivary levels of cortisol correlate well with serum levels in humans [11, 25] and many other mammals, including domestic dogs [26]. It has been suggested that salivary cortisol is a superior measure for the clinical assessment of stress than blood serum due to the simple, low-stress and non-invasive collection procedure [27]. Additionally, the cortisol in saliva is 'free', meaning that it is biologically active, in contrast to serum cortisol where most is bound to proteins [28, 29], rendering it a superior indicator of a stress response. Salivary cortisol is particularly suited to measuring stress in children and subjects requiring multiple sampling, or where there is a requirement to sample in naturalistic settings with minimal stress [30]. The latter two reasons for measuring salivary cortisol are consistent with its established suitability as a parameter and methodology for application in assessing domestic dogs [31].

Although considered non-invasive relative to blood sampling, there is still the possibility of restraint and handling during sample collection impacting on salivary cortisol sampling results. Measurement of plasma cortisol has been shown to have a window of two minutes before a handling effect will be reflected in the metric's level [32]. However, Kobelt and colleagues [33] demonstrated that an interval of up to four minutes from initial handling to completion of salivary sampling in domestic dogs would not confound the measurement of cortisol. In dogs familiar with routine health

checks, including regular handling of their cheeks and mouth, sampling can usually be completed in just thirty seconds [33], so the handling effect is not problematic.

Leukocyte profiles (enumeration of white blood cells from blood smears) have been used successfully across vertebrate taxa as a reliable and inexpensive way of measuring stress-induced changes in animals (see [8] for a comprehensive review). Circulating glucocorticoids, such as cortisol, act to increase the number and percentage of neutrophils, while decreasing the number and percentage of lymphocytes. There is therefore a close positive association between the white blood cell profile, specifically the relative proportion of neutrophils to lymphocytes (NL ratio), and circulating glucocorticoids, across a wide range of mammals [8, 34]. This relationship has been demonstrated in response to both natural stressors and also exogenous administration of stress hormones.

As discussed, hormonal response to stress takes place within minutes, whereas the initial leukocyte response begins over a time span of hours to days. Davis and colleagues [8] conclude that leukocyte counts complement other adrenal hormone measures, such as cortisol concentration, aiding in interpretation of results as leukocytes respond to stressors relatively more slowly. Interestingly, after corticosterone in poultry was no longer elevated, suggestive of acclimatisation, the leukocyte response to stress was found to have remained elevated. This indicates that the leukocyte response to stress is more lasting and can thereby serve as a more reliable indicator of longer term and chronic stress than glucocorticoid sampling, for example in situations where HPA axis fatigue occurs [12, 35]. While salivary cortisol is

useful as a measure of acute stress, NL ratio can be used to assess for longer-term, chronic stress.

Salivary secretory immunoglobulin A (IgA) has emerged as another non-invasive marker of psychological stress in human and other vertebrate studies [36, 37]. IgA has been shown to rise in response to acute (minutes to hours) stress [36], indicating a favourable systemic immune status [38]. Chronic stressors cause a down regulation of IgA, indicating a suppression or dysregulation of immune function [37, 39]. Existing research exploring associations between emotional experience valence and secretory IgA levels suggest that behavioural indicators of distress and negative emotional valence are reflected in decreased IgA secretion [40, 41]. The addition of salivary IgA to markers of stress leads to more robust interpretation of the emotional and welfare experience of animals, rather than general arousal only [42].

Many physiological measures are used to assess the impact of different housing and management practices on the stress and welfare of captive animals. It is important that the handling and sampling techniques used to collect physiological measurements of stress do not confound results by increasing animal stress levels. For this reason, less invasive techniques, such as salivary testing of corticosteroids (e.g. cortisol) and immunological responses (e.g. immunoglobulins), have been favoured. Many studies also only report results for one physiological measure [4]. For rigorous research, especially when assessing animal stress, welfare and quality of life, the use of multiple physiological measures in conjunction with observation of the animals' behaviour is recommended to enable sound interpretation of changes

occurring within individuals, and disparities among treatment groups and populations [5-7].

Physiological changes indicative of symptoms related to welfare problems include increased corticosteroid levels, reduced immune capability and results of complementary methods of stress assessment such as change in leukocyte profiles [6,8]. However, change in a physiological parameter is not always indicative of an animal experiencing a change in its state of welfare. Animals are constantly exhibiting behavioural and physiological responses as they react to their environment and maintain homeostasis [5]. Therefore, it is essential for animal welfare research to focus on indicators that differentiate *normal*/adaptive responses from those indicative of acute or chronic stress that are likely to impact on the animal's welfare.

This pilot study served two key purposes. The first aim was to evaluate the suitability of three physiological measures, salivary cortisol, salivary IgA and plasma NL ratio, to measure stress in young trainee working dogs. The second aim was to compare baseline values with a comparable group of dogs that entered a training kennel facility. This was to establish if a physiological response to entering kennels was evident in these three markers in a population of young working dogs. We predicted that the physiological measures would remain stable over time in dogs that remained in their puppy raising homes, whereas admission to kennel facility would result in significant changes consistent with acute stress.

2. Methods

2.1 Subjects

The subjects were thirty healthy Labrador retriever dogs. All dogs were bred and raised in Australia, by a specialist organisation with the purpose of becoming working dogs for people with a visual impairment. Dogs from this program were born and raised in a breeding centre facility until approximately eight weeks old, then placed into volunteer foster homes. Dogs were routinely returned to the organisation's training kennel facility at approximately 12-14 months of age for a five-day assessment period. This assessment period determined the suitability for each dog to commence the formal working dog training program, or be 'reclassified' (retired from the program as a companion animal) if deemed unsuitable. All dogs experienced a minimum of five days of familiarisation with boarding in the facility between 6-12 months of age. The dogs that participated in this study ranged in age from 10 to 15 months (mean = 13.8 $\pm$ SD 1.4months). The experimental groups showed comparable age ranges: HOME group ranged from 10.4-15.9 months (mean = 12.98); KENNEL group ranged from 11.0 – 15.9 months (mean = 14.71).

2.1.1. Kennel and Home groups

Twenty dogs were randomly selected from the pool of available dogs scheduled to return from the volunteer foster home puppy-raising program to undergo assessment. The dogs sampled in the kennel facility (group: KENNEL) included 11 males (nine neutered) and nine females (four neutered). A control group of 10 randomly selected dogs (group: HOME) included six neutered males and four females (3 neutered) who

remained in their puppy-raising home over the same time frame and were sampled in an identical manner as the kennelled dogs.

2.2. Housing and husbandry

This research was conducted on an existing population of dogs kept under conditions and in environments considered typical for this working dog program. No changes were made to normal protocols for these dogs, other than the sampling of saliva and blood.

2.2.1. Puppy-raising home

All dogs initially resided in their puppy-raising foster homes in suburban Melbourne, Australia. These homes varied in terms of number and composition of family members, space availability and the presence of other animals in the house. All puppy-raising homes met the screening requirements for the working dog organisation, and were closely monitored by the organisation's staff members via phone support and monthly visits. All dogs were housed inside the home residence with access to clean water and were fed at least once daily.

2.2.2. Kennel facility

On admission to the kennel facility, all KENNEL dogs were bathed and staff assessed their health, before being mixed into social groups with conspecifics on a kennel block specifically for dogs undergoing the assessment period. Dogs spent daylight hours in stable social groups comprising four dogs per yard, in adjoining outdoor, open mesh wire fenced, concrete-floored yards (60m²) from 08:00 until 20:00 hours. Dogs were housed in stable pairs in enclosed kennel rooms (1.5m²) overnight and for a daily rest

period at 13:00-14:00 hrs. They were given a full veterinary check on their second day after arrival. Kennel rooms and yards were chemically cleaned by staff daily. Dogs had *ad libitum* access to clean water and were fed daily at approximately 11:30 hrs. They were not given bedding or access to toys, and did not leave the kennel facility during the sampling period except for their assessment period walks with a dog trainer (whom they had not met previously). This working dog program offered no sleepovers away from the kennel facility, or time spent in office environments during the assessment period.

These assessment walks occurred once daily on days 5 to 9 after entering the facility. The first assessment walk on day 5 took place on campus and on paths in surrounding parkland near to the training kennel facility. The supervised, on-leash assessment walks on days 6 to 9 involved spending some time (< 20min) travelling to and from the assessment walk location in a van fitted with secure dog caging.

2.3. Sampling

Subjects initially had saliva and blood collected in their puppy-raising home (Sample 1). Two weeks after this initial sampling, the KENNEL group entered the kennel facility and were sampled two days after arrival (Sample 2: 16 days after Sample 1) and again 14 days later (Sample 3: 30 days after Sample 1). The HOME group were repeatedly sampled in their puppy-raising homes following the same time schedule: i.e. on day +16 and +30 after sample 1. Sampling took place between 08:00 hr and 10:00 hr in a familiar room of the puppy-raising house in close proximity to the home's entrance. The KENNEL group was sampled between 08:00 hr and 08:45 hr in a familiar room adjoining the kennel yards, that was routinely used by staff for grooming, health

checks and administration of medications. The specific time that each sample was collected was documented [36, 43], together with outdoor temperature [44].

2.3.1. Saliva collection and hormone determination

Saliva samples were collected within two minutes of the researcher's arrival at puppy-raising homes and KENNEL dogs exiting their overnight kennel rooms [33]. Saliva was collected by gently swabbing the mouth in the cheek pouches and under the tongue with a cotton pad (Johnson's Pure Cotton Pads, Johnson and Johnson Pacific Pty Ltd, Australia). Non-sterile, latex gloves were worn during saliva sampling. Time taken to collect the sample was approximately 30 seconds. The cotton pad was then placed in a 10ml collection tube with a pipette tip (approx. 20mm in length) inside to facilitate the separation of saliva from the swab during centrifuging. Samples were stored on ice for up to two hours before being transported to the laboratory, where centrifuging at 3000 rpm for 15 minutes separated the saliva and swabs. The swab and straw were removed and discarded, and the saliva was transferred by pipette into a 1.5 mL Eppendorf tube and stored at -20°C until further analysis was conducted.

Saliva samples were analysed for cortisol and IgA by electroimmunoassay (EIA) by IDEXX Laboratories, East Brisbane (Queensland, Australia). Cortisol concentrations were established using *DSL ACTIVE[®] Cortisol EIA (For Saliva) Kit*, (Diagnostic Systems Laboratories: Texas, USA). IgA concentrations were established using *Dog IgA ELISA Quantitation Kit*, (Bethyl Laboratories: Texas, USA). A small number of reported cortisol concentrations over 6.0 $\mu\text{g/dL}$ were presumed to be contaminated [43] and therefore excluded from analysis.

2.3.2. Blood collection and neutrophil: lymphocyte ratio determination

Blood samples (~0.5ml) were taken from a forelimb cephalic vein immediately after saliva collection. Each dog was gently restrained with the front leg extended, while being spoken to calmly by a suitably experienced kennel staff member while the experimenter (MC) performed the venepuncture with a sterile needle (22 gauge) and syringe. All samples were collected within 4min of the onset of interaction (e.g. arrival at puppy-raising home or opening of kennel room door). Immediately after collection, the first few drops of the blood samples were discarded, then one drop of fresh blood was used to prepare a peripheral blood smear using the slide technique [45] on a standard microscope slide. Blood films were air dried within 15 min of collection and sent for a differential leukocyte count (100 leukocytes counted) to IDEXX Laboratories, East Brisbane (Queensland, Australia).

2.4. Statistical analysis

Data were analysed using IBM SPSS Statistics version 25 (IBM: Guildford, UK). A mixed between-within subjects ANOVA was conducted to assess the impact of two different environment groups (HOME, KENNELS) on subjects' salivary cortisol concentration across three time periods (Sample 1 [0 days], Sample 2 [+16 days] and Sample 3 [+30days]) with post hoc follow up as indicated. Alpha was set at $P < 0.05$.

3. Results

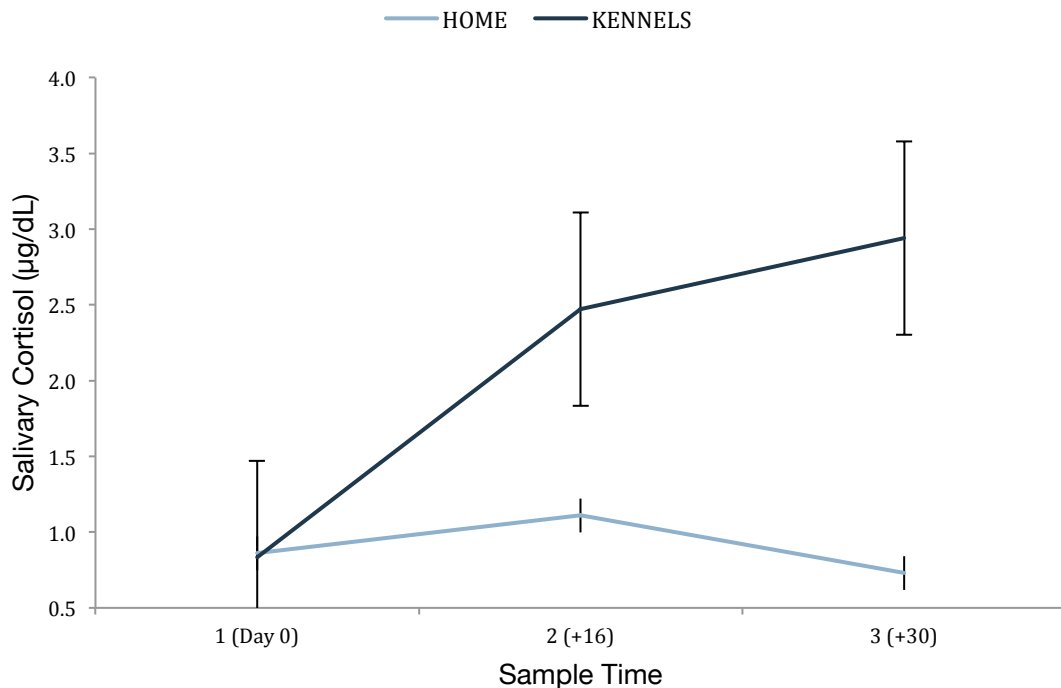
Salivary cortisol, salivary IgA and NL ratio were stable over time in the HOME group, suggesting that they are suitable measures. All three showed significant change in response to the KENNEL group dogs entering the kennel facility.

3.1 Salivary cortisol

Salivary cortisol concentrations were not significantly different between groups at Time 1; however, the KENNEL group showed significantly higher cortisol levels than the HOME group at Sample Times 2 and 3 (Figure 1).

There was a significant interaction between group and time (Wilks Lambda = 0.57, $F_{(2, 26)} = 7.71$, $p = 0.003$, partial eta squared = 0.44). There was a significant main effect for time (Wilks Lambda = 0.57, $F_{(2, 26)} = 7.48$, $p = 0.004$, partial eta squared = 0.43), with both groups demonstrating some variation over time. The main effect comparing the two environments was significant ($F_{(1, 27)} = 13.70$, $p = 0.001$, partial eta squared = 0.40), indicating a substantial difference between the two groups over time that can be attributed to entering the kennel facility.

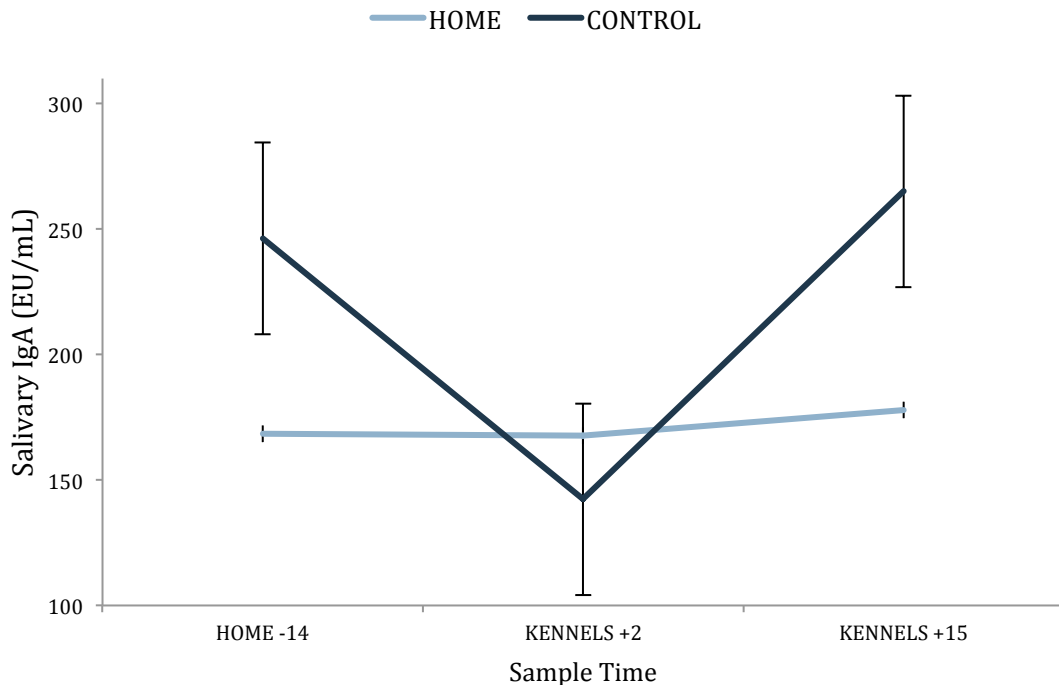
Figure 1. Salivary cortisol ($\mu\text{g/dL}$) of dogs that entered training kennels at Day +14 and those remaining in the home environment. HOME $n=10$; KENNEL $n=20$.



3.2 Salivary Immunoglobulin A

There was an obvious difference between the two groups in IgA at sample time 1, when all dogs were housed in the home environment. This is evident on the profile plot, so one-way repeated measures ANOVAs were utilised to assess the variation within each group over time. There was a significant effect of time in the KENNEL group (Wilks Lambda = 0.59, $F_{(2, 19)} = 6.50$, $p = 0.007$, partial eta squared = 0.41.), but not the HOME group (Wilks Lambda = 0.99, $F_{(2, 26)} = 0.01$, $p = 0.99$, partial eta squared < 0.01.). The mean of the KENNEL group returned to a level not significantly different from the initial at-home value by the third sample time, 16 days after entering the training kennel facility.

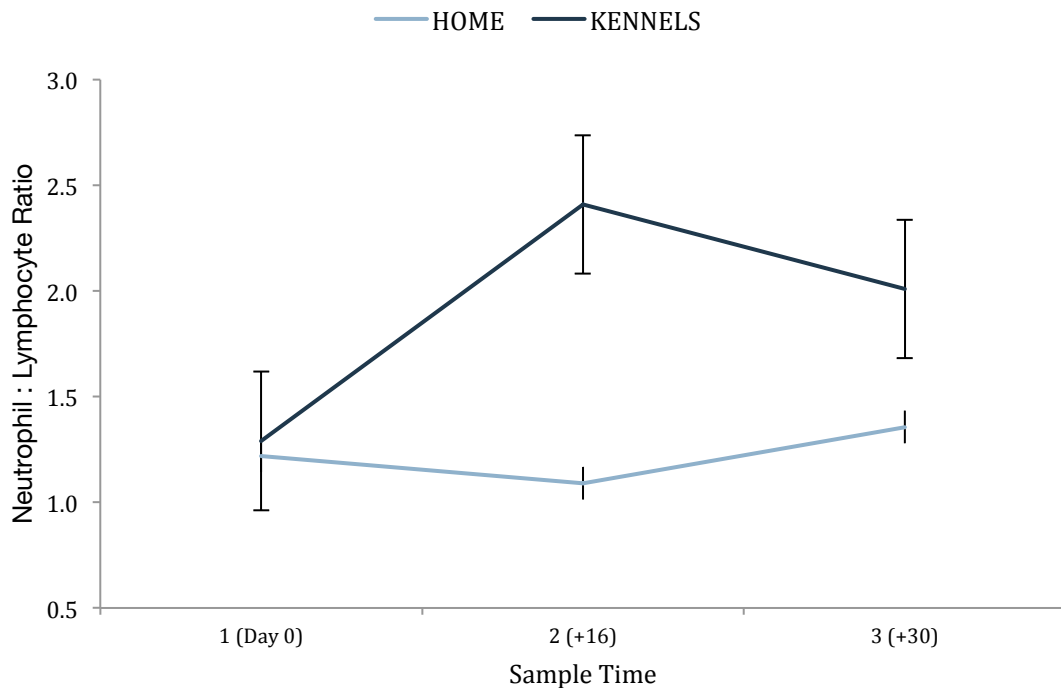
Figure 2. Salivary Immunoglobulin A (EU/mL) of dogs that entered training kennels at Day +14 and those remaining in the home environment. HOME $n=10$; KENNEL $n=20$.



3.3. Neutrophil to Lymphocyte ratio

There was no significant difference in NL ratio between the two groups at sample time 1; however, a significant interaction was observed between group and time (Wilks Lambda = 0.70, $F_{(2, 27)} = 5.71$, $p = 0.009$, partial eta squared = 0.30). There was a significant effect of time on NL ratio (Wilks Lambda = 0.71, $F_{(2, 27)} = 5.14$, $p = 0.011$, partial eta squared = 0.29). The main effect comparing the two environments was significant ($F_{(1, 28)} = 13.54$, $p = 0.001$, partial eta squared = 0.33), indicating a large difference between the two groups over time that reflects the KENNEL group entering the kennel facility (Figure 3).

Figure 3. Neutrophil:Lymphocyte ratio of dogs that entered training kennels at Day +14 and those remaining in the home environment. HOME $n=10$; KENNEL $n=20$.



4. Discussion

In this study we examined three physiological measures of stress in dogs at three time points spread over a 30 day period, demonstrating that young trainee working dogs exhibit a significant stress response to entering the training kennel facility. Salivary cortisol, salivary IgA and plasma NL ratio all proved to be suitable measures of stress for this population of dogs in these environments, demonstrating stability over the 30 day sampling period for dogs that stayed in their puppy raising homes. There was a clear effect of entering the training kennel facility on all three physiological variables i.e. elevation of salivary cortisol, depression of salivary IgA, and elevation of plasma NL ratio. Although it can be challenging to determine when the valence of physiological arousal equates to negative stress that may impact on the welfare of animals in captivity [46], the use of three physiological measures in this study convincingly indicated that the transition from puppy-raising home to training kennel facility elicits a physiological response consistent with distress. Given that dogs are experiencing a notable change in their social structure (inter- and intra-specific), physical environment and daily routine, this is not unexpected. However, such a response had not been previously documented in young trainee guide dogs that had prior exposure to the kennel environment, via previous short stays in the kennel facility.

4.1. Change to social attachment, environment and daily routine is stressful

Entering and living in kennel facilities has been demonstrated to be stressful across a range of dog populations, including companion dogs in commercial boarding

[54], commercial breeding [55], or (displaced in) shelter kennel facilities [56, 57], and working dogs, such as military dogs [58], police dogs [59], racing greyhounds [60] and now in the present study, young working dogs intended to be trained for people with low vision. The dogs that were the focus of this study had previous experience of short stays in the focal kennel facility, and came from a population of dogs that is highly socialised to a range of places and people, factors identified as likely to mitigate fear, anxiety and stress in working dogs [61-64]. However, the combination of elevated salivary cortisol and NL ratio, in conjunction with depressed salivary IgA, indicates that entering the kennel facility and undergoing assessment to determine suitability for training is stressful. This is concerning, not only for the dogs themselves as sentient mammals capable of experiencing distress, but also because the stress experienced in the first two weeks after admission may impact upon their performance, and the success of the working dog program.

4.2. The impact of stress on working dogs and working dog programs

After two weeks of living in the kennel facility, the KENNEL dogs' physiological responses to entering the kennel facility mostly returned to pre-kennel levels. Although salivary cortisol levels remained elevated, the rising salivary IgA and decreasing NL ratio suggested that recovery was underway, and affective state was likely to be improving [65, 66]. Dogs housed in shelters for longer than two weeks have been seen to show significantly lower cortisol levels than dogs in other kennel facilities, although this may indicate HPA axis dysregulation rather than recovery or evidence of resilience [41, 43]. Recent research has shown the benefits of providing long-term kennel residents with a 'sleepover' i.e. time away from the stresses of

kennels life spent in a residential home for a weekend [56]. Dogs on 'sleepovers' typically rest much of the time, suggesting that living in the kennel facility and associated stress leaves dogs with a sleep debt, which is known to have a harmful effect on endocrine function in humans [67, 68] and other animals, including dogs [69]. 'Sleepovers' may offer a strategy to promote coping and reduce the stressful impacts for working dogs that must be housed in kennel facilities.

The failure of stressed dogs to pass assessment or complete their formal training undermines program efficiency and increases costs. The cost of raising and training a dog to the point where they can be operational and matched to a person with low vision exceeds AU\$50,000 (£28,000; US\$35,000) [70]. For non-profit organisations, such as those that provide service and assistance dogs for people with physical disabilities, this is a significant amount. Public knowledge that animals are stressed or have compromised welfare poses a risk to the sustainability of industries utilising animals [71]. If they pass the initial assessment stage, young working dogs in this study will spend five months living in the kennel facility while undertaking formal training. After this, they are matched to a handler with low vision and again return to a domestic home environment, similar to the puppy-raising home of their first twelve months, for the rest of their life. Supporting young dogs through the transition to living in the kennel facility seems logical to optimising the success, economy and sustainability of the program. The use of a composite enrichment program may offer one method of ameliorating the stress responses observed, but further research is required.

4.3 Limitations and future directions

The difference in IgA across groups at sample time 1, when all dogs were in their puppy-raising homes, highlights the influence that variation among individuals can exert on group means. There were no specific outliers responsible for this difference between the randomly selected groups; the two groups just exhibited considerably different means. This illustrates how small sample sizes can impact on the interpretation of physiological measures and is particularly relevant when single variables are relied upon in studies [72]. It is a limitation that behavioural observations of the dogs were not reported in this pilot study. Emergent technology such as wearable activity loggers and facility monitoring sensors should enable future studies to incorporate the assessment behaviour (such as time budgets representing periods of activity, rest and sleep) with relative ease [77-78].

It is possible that differences in the puppy raising home environments of the dogs may influence the baseline measures observed in this study. Although variation in puppy raising home environments is typical of many working dog programs, the presence and number of other dogs, children, activity or feeding prior to sampling, and also weather and temperature should be reported in future studies to aid in both the interpretation of results and comparison between studies. Ideally, sample groups should be matched for these home demographic and dog features (e.g. time since neutering/last season) as much as is feasible within the scope of the program being researched. This would minimise any influence of these factors on physiological measures (be they positive or negative in origin).

Young working dogs found the transition to living in a kennel facility stressful. Abrupt changes to social attachment (both inter- and intra-specific), environment and daily routine can cause stress [73-76]. There is increasing evidence illustrating the significance of canine attachment to humans, particularly in relation to training, problem-solving and work performance [47-50], and it is echoed in physiological findings [43]. This is particularly significant in this cohort of dogs who are rarely left unsupervised for more than an hour at a time during the first year of puppy raising. The relationship between dog-human dyadic attachment and canine affective state is new to scientific examination [51-53]. Consideration for ethological influences such as dog personality profile [79] and age at which prior familiarisation with kennel facility stays [61] occurred are additional considerations for future studies. Future research in this area may inform best practice management of attachment transfer as working dogs transition from the care of puppy raisers, to dog trainers and eventually to operational handlers.

Conclusion

This pilot study demonstrated a significant effect of entering kennels on young trainee working dogs manifested across multiple physiology indicators. It is possible that the stress of admission to the training kennel facility is impacting on the capacity of dogs to learn and perform at optimal levels, affecting the success rate of the overall training program. It is necessary to explore strategies, such as a composite enrichment program in the kennel facility, to assess if stress experienced by young working dogs can be reduced, and how this relates to performance outcomes.

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Ethical statement

This study protocol was approved by the Monash University Animal Ethics Committee (Project number: PSYC200611A).

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Competing interests statement

The authors have no conflict or competing interests to declare.

Contributors (author statement)

MC designed the study and wrote the protocol in consultation with PB and AL. MC managed the literature searches, undertook all data collection and the statistical analysis, and wrote the first draft of the manuscript. All authors contributed to and have approved the final manuscript

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Chapter 6

The effect of a composite enrichment program on the stress physiology and performance of young working dogs housed in a kennel facility.

Mia L Cobb^{*a}, Adrian Carter^a, Alan Lill^b & Pauleen C Bennett^c

^a Turner Institute of Brain and Mental Health and the School of Psychological Sciences
Building 17, Clayton Campus, Wellington Rd, Monash University
Victoria, Australia, 3800

^b Department of Ecology, Environment and Evolution, School of Life Sciences,
Melbourne Campus, La Trobe University,
Victoria, Australia, 3086

^c School of Psychology and Public Health
Bendigo Campus, LaTrobe University, P.O. Box 199, Bendigo
Victoria, Australia, 3552

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Abstract

As societal standards regarding animal use change, industries reliant on animals must be seen to use effective practices. Many working dogs are required to be housed in kennel facilities that have been shown to be stressful environments for dogs. This is important to their quality of life as sentient mammals and also to their ability to perform the tasks asked of them by humans. Enrichment programs, containing elements of environmental, visual, auditory, olfactory and social stimulation, are often introduced to reduce stress. However, composite programs risk overstimulating dogs and may increase levels of stress, reducing rather than improving dog welfare. Industry support for such composite programs also varies between kennel facility workers; with some concerned enrichment programs will waste resources. In this study, we examined three measures of physiology in 67 dogs for 30 days. We demonstrated that a composite enrichment program delivered to 34 of the dogs did not increase physiological stress or negatively influence the assessment or training performance of young working dogs housed in a working dog kennel facility. Access to a composite enrichment program could help dogs cope with the stressful transition to kennels and may relate to improved performance and program success. Complex intra- and inter- individual variations in physiological measures were evident and challenging to interpret. Scientific assessment of animal welfare should utilise statistical analyses that best reflect the experience of the individual. Group-based trajectory analysis to recognise distinct but common patterns of response within a larger group deserves further examination in the field of animal welfare science. Careful monitoring of individual dogs may be required to optimise welfare objectives and performance outcomes.

Keywords:

enrichment; kennel; performance; stress; welfare; working dog

Highlights:

- We examined three measures of physiology in 67 young working dogs over 30 days.
- A composite enrichment program did not increase physiological measures of stress or negatively influence the performance of 34 young working dogs housed in a kennel facility.
- Access to a composite enrichment program could help dogs cope with the transition to kennels and may relate to improved performance and program success.
- Scientific assessment of animal welfare should use statistical analyses that best reflect the experience of the individual; the application of group-based trajectory analysis may serve this purpose.
- Careful monitoring of individual responses to enrichment is likely required to optimise welfare objectives and performance outcomes, but may not be operationally feasible.

1. Introduction

As public scrutiny of the welfare of animals used in society increases, the working dog industry will need to be transparent in delivering public assurance of full life cycle care, including housing and management practices [1]. Many working dogs are required to be housed in kennel facilities, which research has demonstrated to be barren and stressful living environments for dogs [2-6]. In response to this, dogs held in kennel facilities in laboratory, shelter and training contexts have formed the basis for research evaluating various forms of enrichment to the environment of kennelled dogs. Enrichment itself is a dynamic process with a definition that remains variable depending on the context in which it is used [7]. However, it can be broadly understood as the provision of variety for the animal by means of a more complex social, physical and sensory environment. This is generally achieved by making changes to kennel management practices and the physical environment in which the animal lives. Various elements of enrichment have been shown to have a positive effect on the behaviour, physiology and welfare state of dogs housed in kennel environments, including intra- and inter-specific interactions and the provision of toys, resting places, olfactory, auditory and tactile stimulation (see [8] for review).

Evidence of the positive effect of enrichment strategies for dogs from the past twenty-five years has been available in the published scientific literature. Industries such as the working dog sectors have responded variably. A key response encountered during consultation with working dog industry members (gathered from the surveying reported in Chapter 4) has been a response of dismissal or negativity to suggestions of new practices or change existing protocols. Some working dog trainers claimed that enrichment may pose a “distraction from training activities” or “rival to the trainers’ place as the primary source of positive interaction for the dog’s attention”. Other trainers believe that “the stress of entering kennel facility

where enrichment has not been implemented can help to identify more anxious or less adaptable dogs that will be unsuitable training candidates". They believe that "lowering stress levels through enrichment will unnecessarily support unsuitable dogs, 'hiding' them until later in the training process" when resources have been unduly invested. It was unclear if the responses encountered were based on beliefs that kennel and training processes were already optimised, or if there was resistance to changing established practice because it would require effort.

Alternatively, others are embracing the research altogether enthusiastically, sometimes in disregard of the limitations of research conducted to date. An example of this is the emergence of composite enrichment programs. For example, guide dog organisations in the US and UK have implemented kennel enrichment programs. A standard composite program might incorporate social housing, relaxing music, additional positive time with staff, provision of toys on a rotating schedule, the use of olfactory stimulation believed to aid in relaxing dogs such as lavender and a choice of physical environment (e.g. through the provision of raised beds). Whilst the heightened profile of positive welfare for dogs housed in kennels is important, caution needs to be exercised in the practical utilisation of the scientific data published to date. This is a critical issue in the area of working dog welfare, as the effect of the program may not equal the sum of its parts.

For example, Taylor and Mills [4] identify that composite programs containing elements of visual, auditory, olfactory and social enrichment may actually risk overstimulating dogs. This could increase levels of stress in the kennel environment and reduce, rather than improve, levels of canine welfare. This is potentially problematic, not only to the welfare of the animals, but also in terms of their ability to provide the desired service for humans. If too much stimulation leads to increased stress, potential working dogs may fail the training and

accreditation programs for substance detection, guide or assistance work. Further research in realistic conditions is needed to understand the impact of composite enrichment programs on the welfare and performance of dogs housed in kennel facilities.

This aim of this study was twofold. Firstly, we examined whether an industry-representative composite enrichment program improved dog welfare using three established stress physiology markers (salivary cortisol, salivary IgA and NL ratio, refer Chapter 5) over the first 16 days of being housed in a training kennel facility. Secondly, we monitored assessment and longer term training outcomes to identify any impact of the composite enrichment program on the performance of young working dogs.

2. Methods

2.1 Subjects

The subjects were sixty-seven healthy dogs, sampled over the study period of 18 months. All dogs were bred and raised in Australia, by a specialist organisation who provide working dogs to people with low vision. Please refer to Chapter 5 for already provided background information. The dogs that participated in this study ranged in age from 11 to 18 months (mean = 14.3 months, SD = 1.2 months). Most of the dogs were Labrador Retrievers (79%), with some F1 Labrador x Golden Retrievers (19.5%), and one F2 Golden Retriever x Labrador (1.5%). Just over half of the dogs (53.7%) were male (6% entire, 47.7% neutered), and the remainder (46.3%) female (20.9% entire, 25.4% desexed). The majority had yellow coat colour (53.7%), followed by black coat colour (44.8%), with one dog having black and brindle colouring (1.5%). All dogs commenced the study in their puppy-raising homes, two weeks prior to their scheduled arrival to the training kennel facility. The control group (group: CONTROL) comprised 33 dogs that were admitted to the kennel facility and housed following

normal procedures for the organisation. The experimental group (group: ENRICHMENT) included 34 dogs that were admitted to the kennel facility and exposed to a structured composite enrichment program, comprising elements of social, environmental and sensory enrichment. The dogs were randomly allocated to experimental groups. The groups exhibited comparable mean age (CONTROL = 14.5 months; ENRICHMENT = 14.2 months) and composition of Breed (CONTROL = 27 Labradors, 6 Lab x Golden retriever; ENRICHMENT = 26 Labrador, 7 Lab x GR, 1 Golden retriever) and Sex (CONTROL = 18 males [2 entire, 16 neutered] and 15 females [7 entire, 8 neutered] ENRICHMENT = 18 males [2 entire, 16 neutered] and 16 females [7 entire, 9 neutered]).

2.2 Housing and husbandry

This research was undertaken with a population of dogs kept under regular industry conditions, in environments considered typical for this working dog program. No changes were made to normal routines for these dogs, other than the sampling of saliva and blood and introduction of the composite enrichment program for the ENRICHMENT group.

2.2.1. Puppy raising home

All dogs were initially residing in their puppy raising foster homes, as previously detailed in Chapter 5.

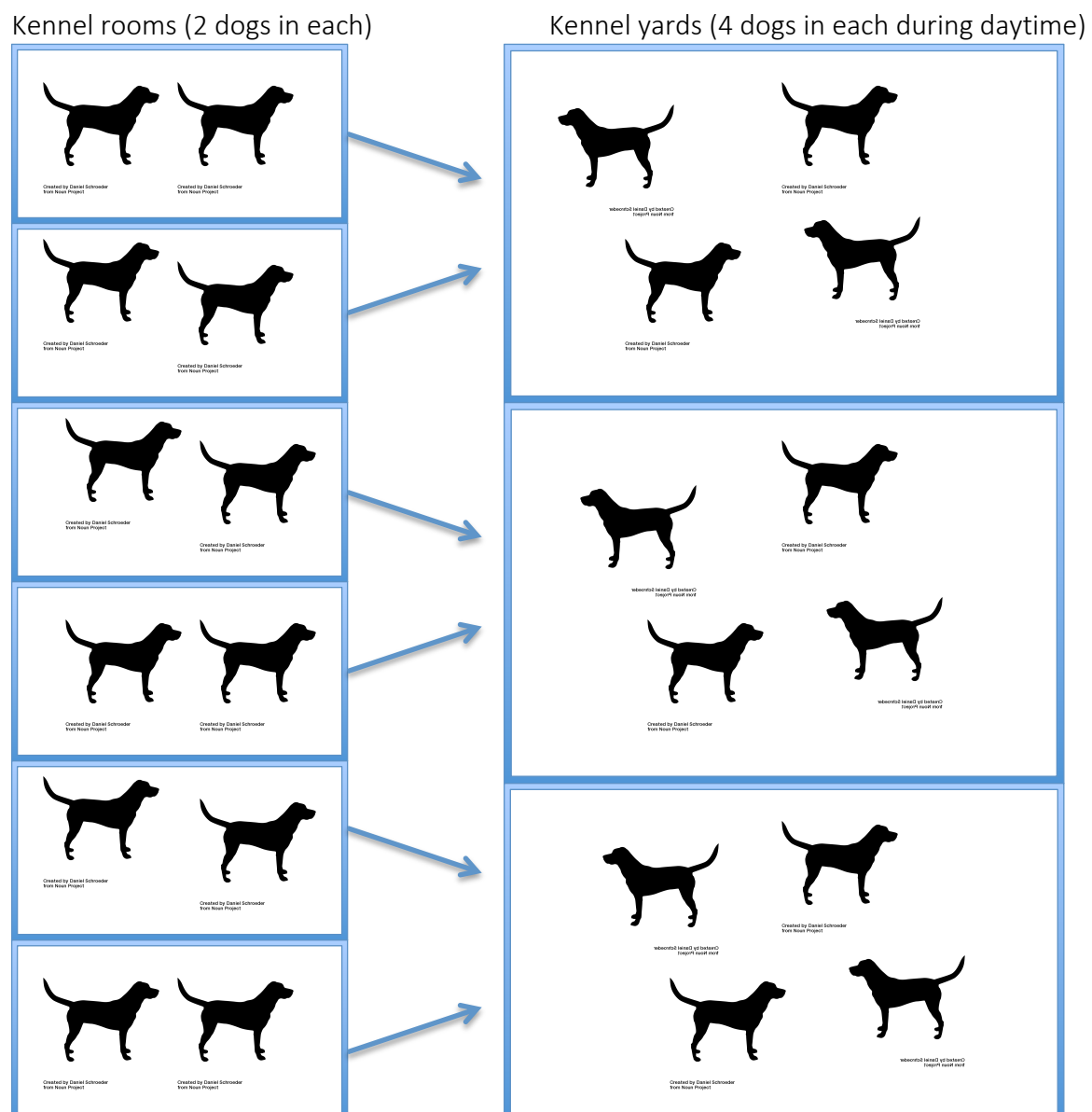
2.2.2. Kennel facility

On admission to the kennel facility, all dogs were physically checked by kennel staff, then mixed into social groups with conspecifics. Dogs spent their days (08:00 hr to 20:00 hr) in static social groups comprised of four dogs, housed alongside each other in outdoor, open mesh wire fenced, concrete-floored yards (60m²) as per Figure 1. Dogs were housed in static pairs in enclosed kennel rooms (1.5m²) overnight and for a daily rest period at 13:00-14:00

hr. These groupings remained stable (i.e. the pairs and day groups were not altered in composition once first introduced following admission to kennels).

Dogs were bathed on admission and given a full veterinary health check on their second day after arrival. Kennel rooms and yards were chemically cleaned and hosed by staff once daily. Dogs had free access to clean water and were fed daily at approximately 11:30 hr.

Figure 1. Showing Kennel Facility Design (not to scale)



2.2.3. Assessment protocol

Dogs were contained to the kennel facility during the sampling period, except for their assessment walks with a dog trainer (who was blinded to dog allocation to experimental group and that the dogs had not met previously) on days 5 to 9 after entering the training kennel facility. This program offered no sleepovers or time spent in office environments away from the kennel facility during the assessment period.

The assessment period comprised one walk each day, during which the dog trainer assessed the dog against 20 established behavioural traits used by this organisation [9]. This assessment was used to determine whether dogs would commence the formal five month training program to attain operational working dog status, or be 'reclassified' (retired to be a companion animal). The first assessment walk on day 5 took place on the grounds of the organisation and in nearby parkland surrounds, accessed by walking paths from the training kennel facility. The supervised on-leash assessment walks on days 6 to 9 involved spending some time (< 20min) travelling to and from the assessment walk location in a van fitted with secure dog caging.

2.2.4 Composite enrichment program

The ENRICHMENT group was provided with raised beds and soft bedding in kennel yards and kennel rooms and had access to a composite program of enrichment activities, deemed acceptable and feasible by the host organisation. For composite enrichment program background literature review and rationale, please refer to Appendix 1. The program was scheduled and located in a readily visible place for easy reference by kennel facility staff (refer Table 1).

Table 1. Schedule for composite enrichment program.

	MON	TUE	WED	THU	FRI	SAT	SUN
Lavender spray (kennel room)	✓	✓	✓	✓	✓	✓	✓
Raised bed (kennel yard and room)	✓	✓	✓	✓	✓	✓	✓
Free run (20min)	✓	✓	✓	✓	✓	✓	✓
Enrichment yard (20min)	Balls & pools	Kongs & toys	Nylabones	Music & staff	Balls & pools	Kongs & scents	Nylabones
Toys in kennel yard (30min)	Mixed	Nylabones	Balls	Kongs & toys	Nylabones	Mixed	Balls
Staff member groom on examination bench	✓	-	-	✓	-	-	-
Staff member spends extra time in yard	✓	✓	✓	✓	✓	✓	✓

2.3 Sampling

Subjects from both groups initially had saliva and blood collected in their puppy raising home (Day -14 to kennel facility admission) as described in Chapter 5. Sampling took place between 08:00 hr and 10:00 hr in the puppy-raising house, close to the home's entrance and in the presence of their primary carer. Two weeks after initial sampling, all dogs entering the kennel facility had saliva collected on days +1, +2, +3, +9 and +16 following admission. Blood collection occurred following admission to the training kennel facility on day +2 and +16. The latter two blood samples coincided with routine vaccination needle events on the same day in an effort to minimise the impact of sampling on the results. Dogs living in the kennel facility were sampled between 08:00 hr and 08:45 hr in a familiar room connected via a walkway to the kennel yards, routinely used by staff for grooming, health checks and administration of medications. The specific time that each sample was collected was documented [10, 11], along with corresponding outdoor temperature [12].

2.4 Statistical analyses

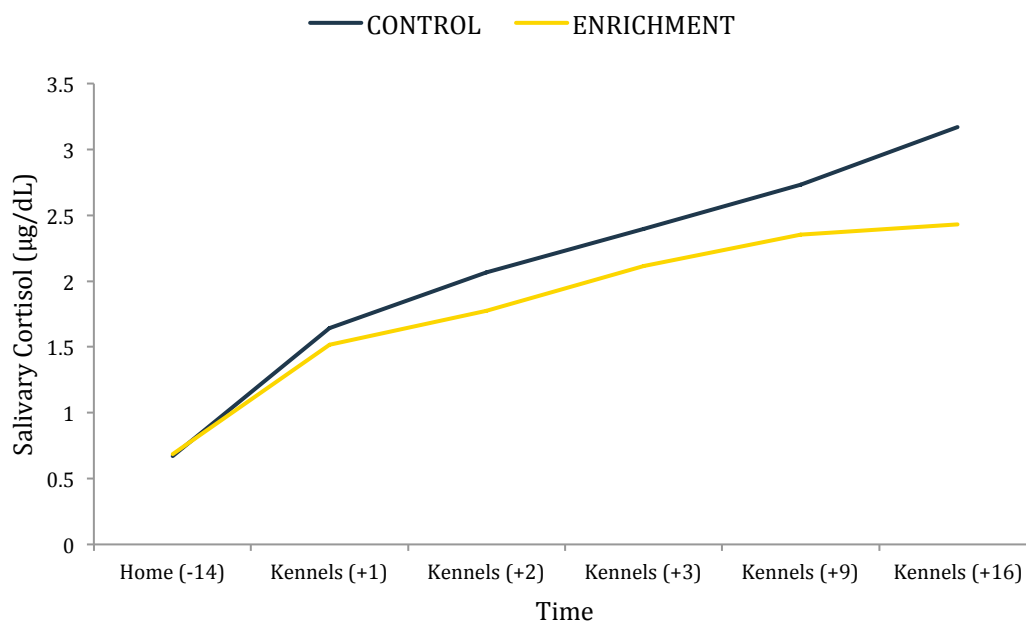
Data were analysed using IBM SPSS Statistics version 25 (IBM: Guildford, UK). Temporal and group variations were determined using mixed between-within subjects, or one-way repeated measures ANOVA ($P < 0.05$ was considered significant). Pearson correlation was used to determine relationships between variables. Chi-square and independent sample t-test were used to compare performance between groups.

3. Results

3.1 Salivary cortisol

Salivary cortisol measurements revealed that the composite enrichment program had no significant effect compared to the control program. There was no significant interaction between experimental group and time, Wilks' Lambda = 0.85, $F_{(5, 28)} = 0.98$, $p = 0.447$, partial eta squared = 0.15. There was a substantial main effect for time, Wilks' Lambda = 0.27, $F(5, 28) = 15.34$, $p < 0.001$, partial eta squared = 0.73, with both groups showing an increase in cortisol concentration across the six time periods (Figure 4). On profile plot, the mean for the control group ($M = 3.17$, $SD = 1.78$) at +16 days after entering the kennel facility was higher than the enrichment group ($M = 2.43$, $SD = 1.73$), but examination for main effect comparing the experimental groups was not significant, $F_{(1, 32)} = 1.08$, $p = 0.307$, partial eta squared = 0.03. To check whether these non-significant results were due to a lack of statistical power, post hoc power analyses using GPower (Faul & Erdfelder, 1992) with power ($1 - \beta$) set at 0.80 and $\alpha = 0.05$, was conducted. This revealed that sample sizes would need to increase to $N = 86$ in order for group differences to reach statistical significance at the 0.05 level.

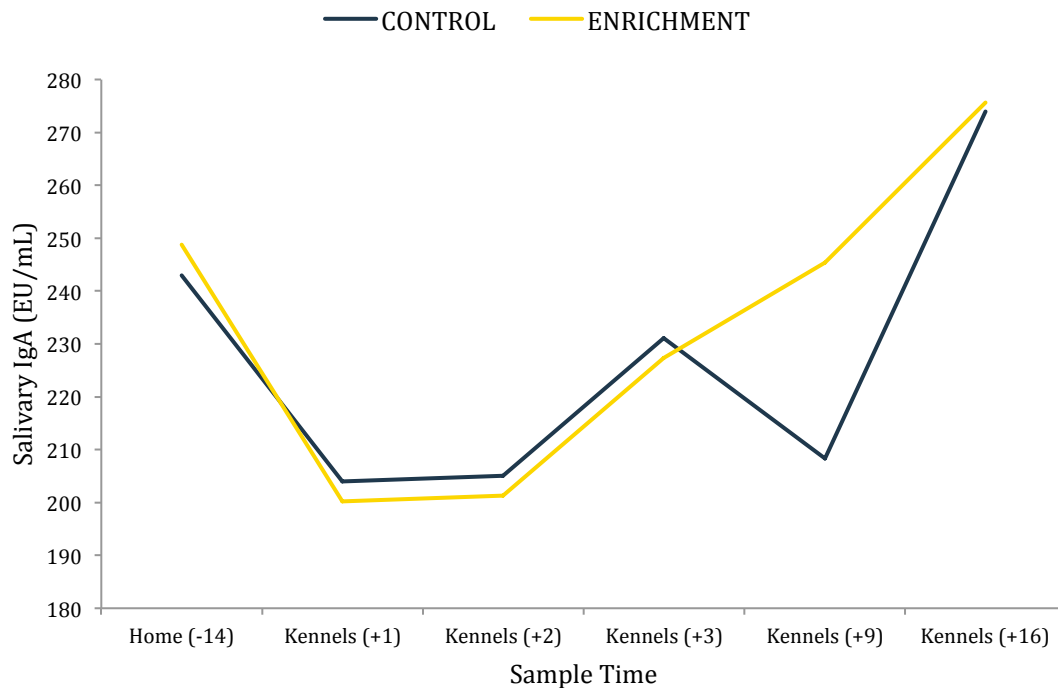
Figure 1. Salivary cortisol concentration of dogs that entered the training kennels at Day 0, showing control ($n = 33$) and enrichment ($n = 34$) experimental groups.



3.2 Salivary Immunoglobulin A

The composite enrichment program did not significantly impact measures of salivary IgA (Figure 5). On inspection of the profile plot, mean salivary IgA at +9 days after entering the kennel facility appeared higher for the enrichment group ($M = 245.41$, $SD = 217.18$) than the control group ($M = 208.34$, $SD = 148.50$). However, there was no significant interaction between groups and time, Wilks' Lambda = 0.95, $F_{(5,53)} = 0.60$, $p = 0.698$, partial eta squared = 0.05, and no main effect for time (Wilks' Lambda = 0.90, $F_{(5,53)} = 1.13$, $p = 0.356$, partial eta squared = 0.10) or experimental group ($F_{(1,57)} = 0.04$, $p = 0.844$, partial eta squared < 0.01). Post hoc power analyses using GPower with power ($1 - \beta$) set at 0.80 and $\alpha = 0.05$, revealed that sample sizes would need to increase to $N = 110$ in order for group differences to reach statistical significance at the 0.05 level.

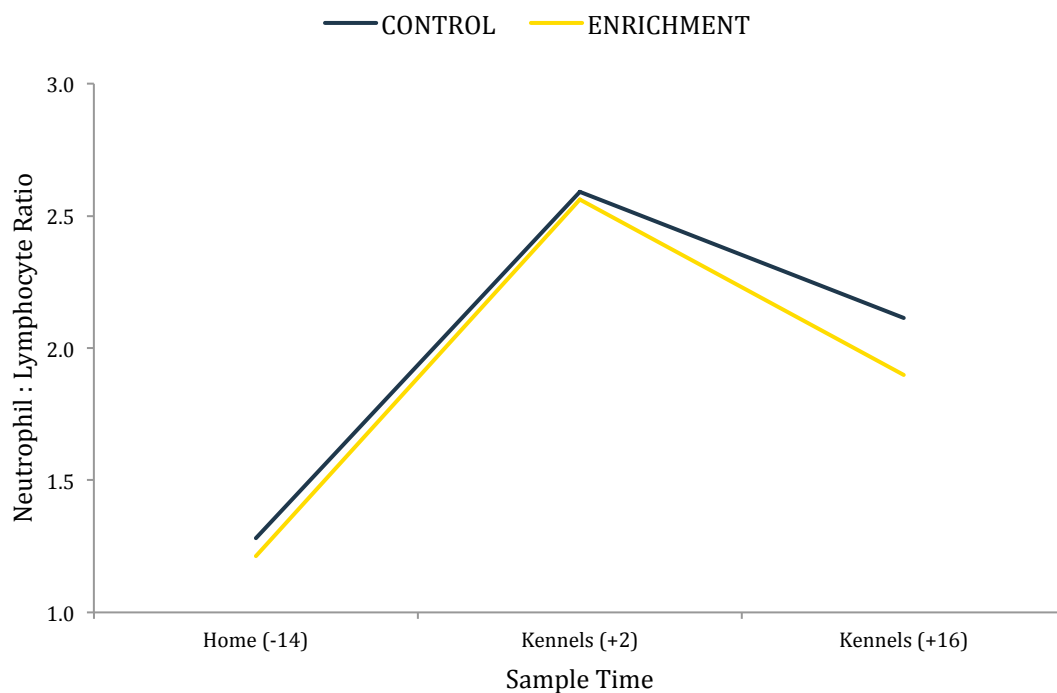
Figure 5. Salivary Immunoglobulin A (EU/mL) of dogs that entered training kennels at Day 0, showing control ($n = 33$) and enrichment ($n = 34$) experimental groups.



3.3 Neutrophil to Lymphocyte ratio

Measures of NL ratio suggested no significant effect of the composite enrichment program (Figure 6). There was no significant interaction between protocol type and time, Wilks' Lambda = .99, $F_{(2, 62)} = 0.98$, $p = 0.894$, partial eta squared < 0.01. There was a substantial main effect for time, Wilks' Lambda = 0.50, $F_{(2, 62)} = 30.70$, $p = <.001$, partial eta squared = 0.498, with both groups showing an increase in NL ratio across the three time periods. Mean NL ratio level at +16 days after entering kennels appeared lower for the enrichment group ($M = 1.90$, $SD = 0.89$) than the control group ($M = 2.11$, $SD = 1.21$), although the main effect comparing the experimental groups was not significant, $F_{(1, 63)} = 0.57$, $p = 0.453$, partial eta squared = 0.01. Post hoc power analyses using GPower with power ($1 - \beta$) set at 0.80 and $\alpha = 0.05$, revealed that sample sizes would need to increase to $N = 108$ in order for group differences to reach statistical significance at the 0.05 level.

Figure 6. Neutrophil to Lymphocyte ratio of dogs entering kennels at Day 0, showing control ($n = 33$) and enrichment ($n = 34$) experimental groups.



3.4 Dog and environmental features

Dog sex, breed, weight and coat colour were not significantly related to salivary cortisol, salivary IgA or NL ratio results ($p > 0.05$). There was no correlation of outdoor temperature or time observed on the physiological measures (salivary cortisol: $r = -0.03$, $n = 390$, $p = 0.624$; salivary IgA: $r = 0.03$, $n = 361$, $p = 0.531$). Finally, there was no correlation between the number of days of prior kennel experience and salivary cortisol, salivary IgA or NL ratio results ($p > 0.05$).

3.5 Effect on performance

3.5.1 Effect on behaviours assessed

Temperament assessment scores (*as described in section 2.2.3*) identified as most relevant to overall dog success by dog training staff revealed no statistically significant effect of the composite enrichment program (Table 2). Dogs in the enrichment group exhibited higher excitability and lower levels of overall suspicion and fear during the five-day assessment process. On the final day of assessment (Day 9 in kennels), dogs that were participating in the composite enrichment program presented the same on dog distraction and anxiety ratings when compared to those in the control group.

Table 2. Mean temperament scores ($\pm$ Standard Deviation) for study cohort from assessment week used to determine suitability for guide dog training.

Group	Excitability	Suspicion	Fear	Dog Distraction	Anxiety
Control (n = 33)	4.3 $\pm$ 2.4	3.8 $\pm$ 2.1	5.2 $\pm$ 2.5	1.8 $\pm$ 0.8	1.9 $\pm$ 0.8
Enrichment (n = 34)	5.4 $\pm$ 2.1	3.3 $\pm$ 2.1	4.8 $\pm$ 2.2	1.8 $\pm$ 0.7	2.0 $\pm$ 0.7
Significance (<i>P</i>)	0.05	0.35	0.54	0.89	0.73

3.5.2 Effect on success

There was a minor statistically significant effect of the composite enrichment program relating to dogs being reclassified, or successfully placed as a working guide dog or member of the breeding program (Table 3). Chi-square test for independence indicated no significant association between experimental group and performance at initial assessment to determine suitability to commence formal guide dog training, $\chi^2_{(1, n = 67)} = 1.13$, $p = 0.52$, $\phi = 0.14$. Pearson's correlation showed a small but significant positive correlation between experimental group and success, with dogs in the enrichment group associated with a higher likelihood of being placed as a working guide or breeding dog, $r = 0.12$, $n = 67$, $p = 0.01$.

Table 3. Assessment and training outcomes for study cohort from Guide Dogs Victoria.

Group	Reclassified at Assessment	Reclassified after some training	Successful Guide or Breeding Dog
Control (n = 33)	52%	15%	33%
Enrichment (n = 34)	41%	12%	47%

4. Discussion

In this study, we demonstrated that a composite enrichment program did not increase physiological stress or negatively influence the assessment or training performance of young working dogs housed in a training kennel facility. Access to a composite enrichment program showed some association to improved performance and program success, but this study did not demonstrate a simple relationship between enrichment, stress and performance.

4.1 The role of enrichment

The effects of environmental and social enrichment have been widely examined in laboratory and livestock settings, with species such as mice, rats and pigs [13-15]. Studies over the past decade have illustrated that environmental enrichment can induce a more positive affective state and optimistic cognitive bias [13, 16]. There is evidence that environmental and social enrichment enhance affiliative behaviour, problem solving and neuroplasticity [15], including new research indicating a cross-talk between blood-cell neuroplasticity-related genes and environmental enrichment in working dogs [17]. Enrichment has been linked to improved learning performance without increased stress in goats [18] and reduced incidence of aggression along with increased play in young pigs [14]. This body of research across many species supports the multi-faceted ways that the provision of a composite enrichment program to young working dogs could support their transition into living in the kennel facility and help in reducing stress. However, careful assessment and monitoring of the social and environmental preferences of individual dogs is probably required to optimise animal welfare and training outcomes.

The distinct personality and learning experiences that reflect the preferences of each dog will likely be reflected in individual coping styles and preferences for different types of

enrichment [19-24]. Behavioural observations to monitor uptake of enrichment opportunities could help to inform a particular dog's program for optimal benefit [25]. For example, a dog that never shows interest in interacting with ball toys but exhibits a strong preference for chewing should have enrichment time allocated to chew toys accordingly. This level of individual support may not be operationally feasible for many working dog organisations, particularly in contexts where resources such as staff time are limited. An alternative argument is that individualised enrichment programs would allow the most efficient allocation of resources so that enrichment items are allocated where they will be of most benefit to support dogs transition to living in a kennel facility. In working dog organisations where puppies are raised with volunteer foster families, puppy raisers could be surveyed at the time of return to inform enrichment preferences.

4.3 Limitations of this study and future directions

Physiological measures of salivary cortisol, salivary IgA and NL ratio can be successfully used to quantify a stress response to the change of physical and social environment, as demonstrated in this study. However, researchers consistently acknowledge intra- and inter-individual differences can be complex and difficult to interpret. This was evident in this study and is likely responsible for the observed differences between group means not achieving statistical significance (i.e. Salivary cortisol and NL ratio at day +16 and salivary IgA at day +9). This study lacked sufficient statistical power to find a significant difference between groups. Power analysis revealed a study cohort of 110 dogs would have offered sufficient power. Applied research of this kind is often limited by the access granted by industry groups to animal populations. It is hoped that the information reported in this study can help to inform future studies in similar areas. Emerging technologies such as heart rate variability

monitoring may also improve our understanding of the affective state of dogs, offering more accurate interpretation in future studies.

Although routinely used, reporting group averages can conceal the manner in which animal responses within the group differ. While sub groups within the sample population might share distinct and common patterns of response, these details are lost when only the group mean is examined. This may misrepresent or oversimplify conclusions made with regard to the welfare experience of the individual animal, as noted by Fraser [26] and Broom [27], and more recently cautioned by Protopopova [28] and Richter and Hintze [29]. As we learn more about the role of animal personality and affective states in relation to stress, attachment and welfare, the use of group means in statistical analysis seems like to continue to obfuscate interpretation of results. While studies and management of individual animals to optimize welfare and performance outcomes may be achievable in some animal industry settings, in larger scale contexts – such as agriculture – it would not be operationally or economically feasible.

Group-based trajectory analysis has been used in human health and psychological sciences for the past decade (see Nagin and Odgers 2010; Nagin 2010), allowing examination of subpopulations sharing common patterns of response (trajectories) within a larger group. These trajectories provide additional detail about distinct but shared response patterns within a group. For example, separate trajectories may indicate different coping styles and could be related to other features of interest, such as canine personality dimensions, attachment to handlers, or success as working dogs. Trajectory modeling presents a new way to explore the welfare experience of animals. It potentially offers a more accurate representation for the ways individuals within a group can differ in their responses to shared environments and stimuli than group means. This is pertinent to the design of future studies

using physiological markers to assess canine welfare. Utilization of this statistical approach will require larger sample sizes for robust results. Access to large study cohorts can be challenging in the field of working dogs and prevented the use of group based trajectory modeling in the present study.

Assessment to determine whether young dogs will be formally trained at these ages is typical in this working dog program. However, it is worth noting that factors such as breed, neuter status, time since last season and how much they have learned in their puppy raising home, may all impact the maturity of temperamental traits observed in breeds such as Labradors and Golden Retrievers between 11 and 18 months of age, when they may still be in the adolescent sensitive period (Dehasse, 1994; Thompson et al, 2010; Harvey et al, 2016; Serpell & Duffy 2016).

Conclusion

This study demonstrated that a composite enrichment program in a working dog kennel facility did not increase physiological measures of stress or negatively influence assessment or training outcomes of young guide dogs. The composite enrichment program may help some dogs cope with the transition from puppy-raising foster home to living in a training kennel facility, but further research is required. This study did not demonstrate a simple relationship between enrichment, stress and performance. Careful monitoring of individual responses to enrichment is probably required to optimise welfare objectives and performance outcomes. This may not be operationally feasible, but could offer improved economic efficiency. Scientific assessment of animal welfare should utilise statistical analyses that best reflect the experience of the individual. The application of group-based trajectory analysis to recognise distinct but common patterns of response, shared by individuals within

a larger group, deserves further examination in the field of animal welfare science. Optimised working dog welfare and performance will be achieved when the social and environmental requirements and preferences of individual dogs are identified and met.

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Ethics statement

This study protocol was approved by the Monash University Animal Ethics Committee (Project number: PSYC200611A).

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Competing interests statement

The authors have no conflict or competing interests to declare.

Contributors (author statement)

MC designed the study and wrote the protocol in consultation with PB and AL. MC managed the literature searches, undertook all data collection and the statistical analysis, and wrote the first draft of the manuscript. All authors contributed to and have approved the final manuscript

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Chapter 6: Appendix 1

1. Determining what to include in the composite enrichment program

We reviewed the scientific research in order to determine the enrichment strategies demonstrated to be effective in improving the welfare of kennelled dogs. Following consultation with experts from other working dog organisations and zoos using composite enrichment programs, the collated information was used to inform the design of an industry-representative composite enrichment program. An overview of the information reviewed is presented here.

1.1. Literature review

Mammals have evolved a capacity to expect change and challenges and a need to seek information which makes them unsuited to a dependent lifestyle in captivity where all their material needs can be met with minimal effort on their part [1]. Even highly domesticated animals, such as the domestic dog *Canis lupus familiaris*, retain a behavioural repertoire shaped by natural selection during their evolutionary history [2]. It is important not to compare them too closely to their recognised ancestors the wolves however, as there are many significant differences, both behavioural and morphological, arising from many generations of artificial selection [3, 4]. This emphasises the need for rigorous research conducted *in situ*, specifically targeting kennelled domestic dogs rather than extrapolating or inferring information from research conducted in other settings or with other species.

Beerda and colleagues [5] suggest that certain behaviours observed in kennelled dogs, (see Stephen and Ledger [6] for an ethogram of observed behaviours associated with poor canine welfare), such as coprophagy, excessive vocalising and stereotypic (repetitive behaviour patterns that serve no apparent purpose) behaviours like floor licking and autogrooming,

may indicate chronic stress in dogs and, as such, can help to identify environments where welfare could be improved. If this assumption is accepted then existing research clearly shows that enriching the environment of resident dogs by increasing the physical and temporal complexity of their pens and/or routines, or providing the opportunity for increased social contact offers a significant chance to improve their overall well being [7]. Enrichment can be a means of producing a desired change in behaviour, as demonstrated by a reduction of over 80% in the time spent exhibiting abnormal stereotypies and destructive behaviours, such as chewing the fencing or kennel fittings [7-9].

Enrichment for domestic dogs is generally simplified into two main categories – social (or animate) enrichment and environmental (or inanimate) enrichment.

1.1.1. Social Enrichment

Appropriate social contact (both conspecific and with humans) along with adequate physical and mental stimulation is crucial in attaining and maintaining high standards of welfare [10].

Dog-Dog interaction

It is widely suggested that kennelled dogs should be housed in pairs or groups of three or more animals as the mere sights, smell and sounds of other dogs can greatly increase the complexity of the confined environment, fulfilling an enriching objective [4, 11, 12]. This is not always possible in shelter environments where unknown health and quarantine requirements often require animals to be housed individually. However, opportunities for social housing are greater in training, working and boarding facilities for the more stable resident populations of working dogs where behavioural traits of individual animals are well known.

Singly housed dogs are generally less active than dogs housed in pairs or groups and are more likely to spend time in stereotyped behaviour and show signs of boredom [8]. In comparison, social housing with conspecifics has been shown to result in reduced rates of aggression, excitement and uncertainty in domestic dog populations [13]. Hubrecht [7, 11, 12], Prescott [10] and colleagues outline benefits such as a significant reduction in demonstrated stereotypies and increased olfactory information in yards that offer increased opportunities for social interactions provided through pair and group housing. However they also mention the importance for adequate staffing to properly monitor any tension between individuals and to deal promptly and correctly with inappropriate physical conflict between individual dogs if it occurs.

For this reason, due care should be taken when selecting which individuals are compatible to place together in a group housing setting [4]. Pre-mixing individuals prior to introduction to a larger dynamic group has proven a successful strategy in reducing aggression and forming more stable social groups in sows [14] and is a technique currently used as a routine part of the canine social housing process at Guide Dogs Victoria (Australia).

Dog-Human interaction

In a kennel environment, as identified by Hubrecht [7], the opportunities to socialise with people are often limited as staff are occupied with duties such as cleaning and feeding. In addition, these limited interactions may be less than positive. For example, staff members' contact with dogs may be limited to the administration of medication, bathing or verbally reprimanding dogs for excessive barking. Hubrecht suggests that social enrichment can be provided by offering more appropriate, or more varied, opportunities for social interactions between people and dogs.

The interactions between domestic dogs and their human carers have been suggested to be possibly more important than conspecific interaction, with well-documented effects on both physiology and behaviour in dogs caused by human interactions [15-17]. In the case of dogs bred for guiding people with a visual impairment, this is probably more so, due to the specific puppy nurturing and socialisation programs used by most organisations. For example, the program at Guide Dogs Victoria encourages positive human interaction with pups from 10 days of age. Volunteers are trained to spend time with litters of pups, interacting with them in positive ways. There is also a tailored and staff-supported Puppy Raising Program, in which individual dogs are fostered by members of the public community and raised in their residential homes. This program again promotes a strong dog-human bond from eight weeks of age until the dog is returned for its temperamental and physical assessment at around 14 months of age to determine if it will enter formal training.

Daily grooming sessions with kennel staff have been recommended as a form of positive human interaction which also aids in reducing stress [4, 18]. Properly conducted training sessions reportedly improve the relationship between humans and dogs, likewise informal training, such a grooming sessions held on a veterinary examination bench, can make routine examinations and veterinary treatment much easier and less stressful [1]. Loveridge [19] discusses the importance of training in a balanced animal training programme of 'total care' which provides variety and stimulation for both the dogs and carers, as does Wells [4] who also indicates that human-dog play can be very positive.

Loveridge [19] outlines a successful program of regular supervised outdoor exercise and socialisation (free running in small-medium groups} utilised at the WALTHAM Centre for Pet Nutrition. Prescott [9] recommends that such groups must always be supervised by suitably trained staff and do not exceed ten individual dogs for reasons of adequate supervision,

individual attention, maintaining appropriate levels of excitement (and stimulation) and for reduction of social tension, which will assist less confident individuals in the group. Interestingly, there has been no documented evidence of extra physical exercise improving welfare of dogs. One might expect this to be effective, especially if conducted in a varied environment or different location such as by going for a walk with a human companion [12]. Other environmental enrichment factors clearly improve dog welfare.

1.1.2. Environmental enrichment

Environmental enrichment can allow dogs greater choice of activity through the provision of physical items within pens and by allowing dogs a greater choice of location or micro-environment within the pen [8]. Prescott and colleagues [20] suggest that a designated, specialised area that is well-equipped with enrichment equipment such as stairs, ramps, tunnels and toys should be used for suitably supervised enrichment sessions. Ideally, this area should be used in preference to leaving dogs housed in pens and should never be empty. The use of plastic tunnels can also give dogs an element of choice about their location and if free-standing can be repositioned by the dogs themselves, adding complexity to the environment [20].

While several authors suggest the use of yard furniture to give dogs a more three-dimensional environment, such as the option of elevation [4, 8, 12, 19, 21], this has been documented to result in encounters where guarding behaviours were observed and may not be suitable in all contexts [8].

1.1.3. Sensory enrichment

According to Poole [1] the degree of sensitivity of perception for most mammals from greatest to least importance is: smell, hearing, touch and sight. Enrichment activities within each of these sensory domains can improve welfare of kennelled dogs.

Olfactory

The value of odours for improving psychological well being by influencing moods and behaviour has been well documented in literature relating to human trials [22]. The domestic dog's olfactory acuity is considered to be approximately 1000 to 10,000 times better than that of humans [3]. Accordingly, past studies into dogs, other mammals and enrichment in zoo contexts have highlighted the potential for olfactory stimulation to play a role in enriching environments that is often overlooked by human care takers [1, 2, 22-25].

In study conducted in a UK rescue shelter kennel environment, Graham and colleagues explored the use of essential oils as olfactory stimulation and found that dogs reacted significantly in a similar manner to that documented in people [24]. Essential oils were diffused around the kennel environment to create as even a distribution of odorant as possible. Exposure to the scents of Lavender and Chamomile resulted in the dogs behaving in a manner suggestive of relaxation (i.e. resting); while dogs exposed to scents of Peppermint and Rosemary encouraged dogs to spend more of their time alert (i.e. standing, moving). During the course of the study, the dogs did not habituate to any of the odours, particularly those popular for their reported stress-reducing properties. Lavender scent has been found to reduce stress associated with travel in both dogs [25] and pigs [26].

Olfactory enrichment can also come from the introduction of unusual smells in a formalised enrichment area, such as that recommended by Prescott *et al.* [20]. The introduction of non-toxic substrates such as eucalyptus mulch has been shown to attract much interest by canid

species at Melbourne Zoo (Roe, 2004). Melbourne Zoo have also utilised essential oils and commercial perfumes in a different manner to the study outlined above, using just a single drop of a variable scent in random locations around the enclosures to create interest and promote increased activity in the large cat populations.

Auditory

Similarly to olfaction, the value of music and other forms of auditory stimulation for improving psychological wellbeing are well documented in humans [27]. Domestic dogs' auditory acuity is considered to be four times greater than that of humans [12], suggesting that dogs may also benefit from auditory stimulation. A study has shown that classical music appears to be beneficial in a kennel environment, resulting in dogs reacting significantly by increasing their time spent resting quietly [27]. Newberry [2] noted the importance that auditory stimulation could play in enrichment and random sounds are often played to stimulate zoo animals. Management of sound levels within the kennel facility must also be taken into account given the sensitivity of canine hearing. This extends not only to the consideration for the volume of sounds which are introduced with the aim of improving welfare, such as music, but also to guiding staff in appropriate processes to reduce barking dog and the use of noise abatement kennel design features [28, 29].

Touch

Massage therapy for infants and children has been found to result in lower anxiety levels and lower physiological measures of stress, such as cortisol, as well as increased attentiveness and decreased latency to sleep [30-32]. Others have noted the positive effects of using touch via human grooming of dogs and recommended regular sessions between dogs and their carers [4, 18].

Chewing is a natural canine behaviour, forming an important method for dogs to explore their environment and a rewarding experience [9]. Giving dogs the opportunity to chew and tear things can therefore be seen as beneficial, and putting something as simple as a cardboard box into a dog's yard can provide a great deal of entertainment. Zoo keepers suggest the use of simple activity toys that can be made by stuffing a cardboard box or simple paper/flour/water piñata with shredded paper and toys that can provide hours of mental and physical activity. Untreated soft-wood, rawhide or nylon chews can be a great source of interest and enrichment as well as assisting with dental hygiene. Such items should be regularly checked for excess wear and replaced as appropriate [9].

Visual

Good kennel and yard design should allow dogs to satisfy their natural inquisitiveness about what is happening outside of their enclosure [12]. It is interesting to note that humans recover more quickly from surgery when they have a view from their room [2, 33], although there is no comparable literature for canids. Research conducted in a rescue shelter kennel facility [34] demonstrated that, although dogs show a preference to maintain visual contact with other dogs, it had no effect on dog activity or vocalisation.

Toys

The use of toys as a form of enrichment for dogs has been found to encourage play and reduce boredom, whilst promoting exploration, increasing activity and reducing abnormal behaviours [8, 35]. The addition of toys to a yard or pen increases opportunities for dogs to express species-typical postures and activities [20]. Toys that are novel objects are more likely to be picked up and carried and are more likely to stimulate object play than heavy permanent fixtures [2, 36]. The use of suitable toys in social play can allow dogs to play more vigorously as toys can be pulled, chewed, stalked, shaken, thrown and carried [20]. Rooney

and Bradshaw [37, 38] (2003) compared the effect of dogs winning or losing 20 consecutive tug-of-war sessions with a person. The composite behavioural test results showed that confidence and 'dominance' of individual dogs were unaffected by the outcome of the trials, although playful attention seeking increased after winning. The supervision and number of toys provided in a group setting should be considered to prevent guarding or potentially aggressive situations [2]. Suspending toys in yards can prevent monopolisation, keep from soiling and prevent from blocking drains [8].

Wells found some evidence of adult dogs habituating to toys in a rescue shelter environment, suggesting rotation could be an important aspect to canine toy provision [35]. This concept is supported by Poole [1]. However, Hubrecht [7, 8] found that even after two months, dogs utilised toys suspended in their yards greater than 24% of their time. This demonstrates that the dogs were making extensive use of the toys, beyond the initial period of their introduction. Prescott and colleagues suggest that some degree of novelty arises from the introduction and regular rotation of materials, providing an element of unpredictability [20]. This anticipated input of new information can aid to satisfy curiosity and maintain activity.

1.1.4. Limitations and constraints in applying enrichment research

While the results presented above are encouraging, much of the available information is preliminary. There are also several factors that limit the generalizability of the findings. One important limitation is that it is necessary to identify the context in which dogs are being housed, since this may impose substantial constraints on enrichment possibilities [7]. For example, in a Guide Dog Training Kennel context, certain behaviours, such as food and scent tracking, must not be encouraged because of the potential implications for the working requirements of the dogs. Encouraging these traits may be desirable in other fields, such as

quarantine or border patrol detection work. A detailed working knowledge of job requirements should inform the type of enrichment provided to dogs in different contexts.

Another concern is that many enrichment programs have been introduced intuitively. Rather than designing functional enrichment programs based on the requirements of a particular species and the specific behaviours wanting to be promoted [39], programs are often composed without due consideration for the possible effects of combining elements. Indeed, there has been some speculation that enrichment programs often enrich the people surrounding the animals as much as the animals themselves [2]. Enrichment programs may result in an improvement of public image of the facility, although it is important to control which people are involved in such programs, as numerous visitors can be a source of stressful excitement rather than complimenting environmental enrichment.

Finally, the cost effectiveness of different forms of enrichment is rarely evaluated, even though existing programs are often constrained by financial costs and time demands on carers [2]. Failing to acknowledge that a composite enrichment program's effects may not equal the sum of its parts risks the use of more resources than is actually required. This may result in the program moving from provision of healthy stimulation to unhealthy stress, an implication of enrichment that has been identified previously [40, 41].

These limitations need not imply that existing programs have no value. Dogs exposed to a more complex environment show physiological changes such as more rapid brain maturation as well as changes in behavioural responsiveness [9] and the benefits can be long lasting. Hubrecht found no sign of habituation being evident in regard to the enrichment program studied [8]. There were also no deleterious effects on the dogs studied or their husbandry and observed measurable beneficial effects to their behaviour. An appropriate enrichment program is believed to increase the complexity of the individual dog's behaviour,

substantially change the expression of behaviour and help to prevent undesirable behaviours [8].

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Chapter 7

A systematic review and meta-analysis of salivary cortisol measurement in domestic canines

M.L. Cobb^a, K. Iskandarani^b, V.M. Chinchilli^b, and N.A. Dreschel^c

^a Anthrozoology Research Group, School of Psychological Sciences,
18 Innovation Walk, Clayton Campus, Monash University, VIC 3800 Australia

^b Department of Public Health Sciences, College of Medicine,
The Pennsylvania State University, 90 Hope Drive, Suite 2200, Hershey, PA 17033-0855 USA

^c Department of Animal Science,
The Pennsylvania State University. 324 Henning Building, University Park, PA 16802 USA

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Abstract

Salivary cortisol is widely used as an indicator of stress and welfare in canine research. However, much remains unclear about the basic features of this hormone marker in domestic dogs. This systematic review and meta-analysis aimed to determine a reference range for cortisol concentration in the saliva of dogs, and examine population effects and experimental considerations relating to salivary cortisol concentrations. A systematic review of literature databases and conference proceedings from 1992-2012 identified 61 peer-reviewed studies utilizing domestic dog salivary cortisol. Researchers were contacted via email and 31 raw data sets representing a total of 5,153 samples from 1,205 dogs were shared. Meta-analysis provided a cortisol concentration range of 0 – 33.79 mg/dL (mean 0.45 mg/dL, SEM 0.13). Significant effects ($P < 0.05$) were found for: sex and neuter status, age, regular living environment, time in environment prior to testing, testing environment, owner presence during testing, and collection media. Significant effects were not found for: dog breed, body weight, dog type, coat color, assay type, exercise, eating, or use of salivary stimulant. Care should be taken when using cortisol studies for dogs at a group or population level as there is a large amount of intra- and inter-individual variability and external variables could influence salivary cortisol concentration. This analysis highlights the importance of carefully controlling experimental design in order to compare samples within and between individual dogs, as well as establishing and using best practices for saliva collection. Caution should be exercised in comparing different studies, as the results could be a reflection of a plethora of factors.

Key words: dog; cortisol; salivary; stress; welfare; meta-analysis

1. Introduction

The relationship between stress, health and wellbeing of domestic dogs is a significant area of scientific interest concerning canines in both companion and working contexts [1,2]. Though widely used as an indicator of stress and welfare in canine research, much remains unclear about the basic features of salivary cortisol in domestic dogs. This systematic review and meta-analysis aimed to determine a reference range for salivary cortisol concentration in domestic dogs and to examine how canine characteristics, environmental effects and experimental design may impact cortisol concentration in saliva.

1.1 Use of salivary cortisol concentration in domestic canine research

Cortisol is extensively used as a measure of hypothalamic-pituitary-adrenal axis (HPA) activity, and is found in plasma, saliva, feces, urine, and hair of many species. In healthy dogs, cortisol concentration in saliva is highly correlated with plasma cortisol, as unbound cortisol passively diffuses from blood into saliva [3,4]. Illness and medications influencing protein binding may reduce the correlation between plasma and salivary cortisol concentrations. Saliva collection is relatively non-invasive, and can be collected and stored at convenient and meaningful times of the day in a variety of settings. Although animal handling is required, saliva collection is tolerated well by most dogs and is not technically challenging, allowing people to be easily trained to collect samples [5]. Collection involves saturating absorbent collection material with saliva in the dog's mouth, with or without the presence of a salivary stimulant. It has been shown that if the collection procedure takes < 4 min, there is no handling effect on the cortisol

concentration that sample [6]. Saliva is then extracted from the absorbent material, frozen for an interim period, and tested for cortisol concentration using validated radio- or enzyme-linked immuno-assays.

1.2 Rationale for meta-analysis

Canine salivary cortisol concentration is used as a measure of animal welfare, generalized stress response, response to acute stimuli, and response to interventions in a variety of testing environments, as an indicator of aging and of diseases, such as hyperadrenocorticism. Intra- and inter-individual variations in canine cortisol concentrations are often cited as limitations in salivary cortisol interpretation. With the increasing use of salivary cortisol concentration as a measure of canine stress and welfare in the literature, it is important to establish range limits and identify any canine, environmental and experimental effects on this popular marker. Meta-analysis is a formal, quantitative statistical technique for combining the results from multiple independent studies to systematically derive conclusions about that body of research. It allows results from studies that have great variability (study heterogeneity) to be pooled and analyzed effectively. We determined to use a random-effects meta-analytic model that accounts for study heterogeneity. This provides confidence that the higher the study heterogeneity, then (1) the larger the resultant variance, (2) the wider the resultant confidence interval, and (3) the smaller the chance of detecting statistical significance. This epidemiological study design is widely used in medical research [7].

1.3 Objectives

1.3.1 Individual canine characteristics

The first objective of this study is to establish normal values and ranges for canine salivary cortisol concentration and to investigate the effects of age, sex, color and neutering status on cortisol concentration. In addition, we seek to examine the effect of breed and purpose of dog, separately from environmental differences, on salivary cortisol concentration.

1.3.2 Environmental effects

Objectives of the study also include studying the effects of a dog's living situation on salivary cortisol concentrations. Previous research suggests that dogs living socially with other dogs may not have as pronounced a cortisol response to a specific stressor as those that live alone [8]. Research also indicates that cortisol concentrations may vary between dogs sampled in their home environment; at a boarding kennel, rescue shelter or veterinary hospital; in competition; or in a working or training kennel facility [9]. In addition, the dogs' familiarity with the testing environment, the duration they have been housed there, and whether their regular owner or handler is present at the time of testing could affect cortisol concentrations [10,11].

1.3.3 Experimental considerations

In many species, cortisol has strong diurnal, circadian and seasonal rhythms of secretion. While a number of studies have failed to show a diurnal rhythm in plasma or salivary cortisol concentration in dogs [12-15], Beerda and colleagues [16] recorded

significantly higher mean salivary cortisol concentrations in their canine subjects in the morning than during the rest of the day. This study seeks to investigate the role of sampling time on canine salivary cortisol concentrations further, with the capacity to compare many dogs from multiple studies and countries, across various time points.

Exercise has been shown to increase plasma cortisol concentrations in dogs [17], but the effect of exercise on salivary cortisol in dogs is unknown. Therefore, exercise may potentially pose a confounding variable in studies that include exercise as part of the experimental protocol [18,19]. Additionally, while ingestion of a protein rich meal has been shown to increase salivary cortisol concentration for up to 2 h in humans [20], this response has not been tested in dogs to our knowledge.

Cortisol concentration has been measured in saliva using both radioimmunoassay (RIA) and enzyme linked immunoassays (ELISA). In addition, different saliva collection materials, as well as stimulants to increase salivary flow, have been used by canine researchers. Collection materials can affect determination of some salivary biomarkers, as well as sample collection volume [5]. A final objective of this meta-analysis is to clarify any effects that differences in experimental methodology and study design might have on cortisol concentration results.

2. Methods

2.1. Identification of studies

We searched databases PubMed, Web of Science, Biological Abstracts (via Ovid), Scopus, PsychInfo, ProQuest and Google Scholar for peer-reviewed studies utilizing domestic canine salivary cortisol from 1992-2012. The keyword terms *saliva**, and *cortisol*, were used in addition to *dog**, *pup** or *canine**. The proceedings for the Canine Science Forum 2008, 2010 and 2012 were visually scanned and electronically searched for *cortisol*, *stress* and *salivary*. The International Society for Applied Ethology proceedings for all annual conferences 2002-2012 and the proceedings for all biennial International Working Dog Breeding Association Conferences 2001-2011 were visually and electronically searched for *saliva**. The Penn Vet Working Dog Conference 2010 and 2011 proceedings were visually scanned for *salivary cortisol*. Identified abstracts were read to establish if the study included determination of canine salivary cortisol concentration and general methodology. Figure 1 shows a flow diagram that summarizes all stages of the systematic review process, including the numbers of studies identified at each stage and any reasons for exclusion.

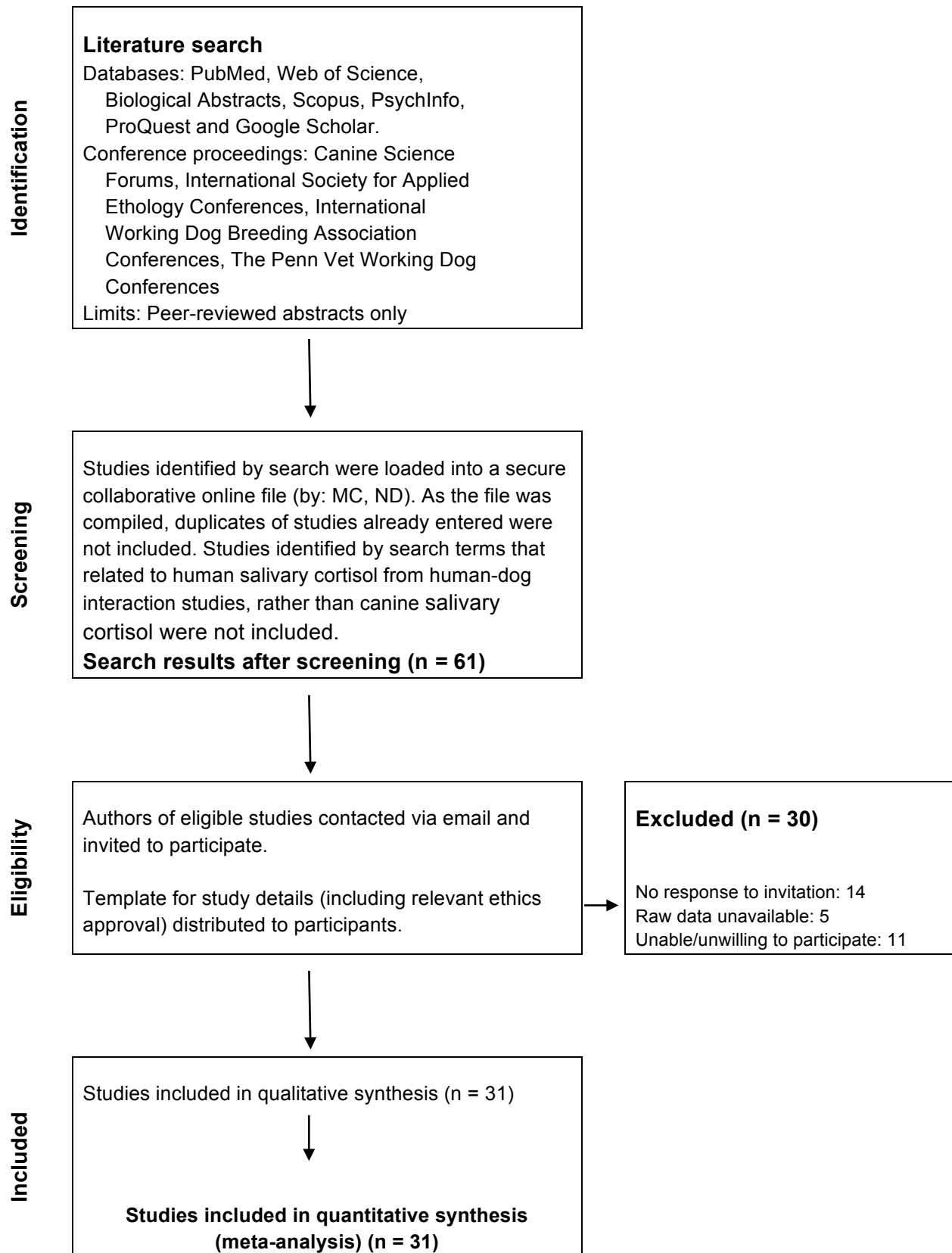


Figure 1: Flow diagram showing phases of systematic review and study selection for meta-analysis.

2.2 Inclusion criteria

Lead investigators (MC, ND) independently retrieved both English and non-English articles identified through search for review using predetermined inclusion criteria. Studies were identified as eligible for inclusion if they: (1) were peer-reviewed (including those published in scientific journals and/or presented at meetings requiring a peer-reviewed abstract process), (2) included domestic canine (*Canis lupus familiaris*) subjects, (3) involved determination of salivary cortisol concentration by enzyme-linked immunoassay (ELISA/EIA) or radio immunoassay (RIA). We identified 61 studies that met these eligibility criteria. The corresponding author (or co-authors in cases where initial email contact failed) of each study was contacted via email request and templates were provided for a study summary and raw data set. No studies were excluded by the investigators after author contact. Data from older studies proved more difficult to obtain as it was sometimes inaccessible, irretrievable, or the study authors were not able to be successfully contacted. Of the research teams successfully contacted, study summaries and raw data sets were provided for inclusion in the meta-analysis from 31 peer-reviewed studies, representing 1205 individual dogs and 5153 salivary cortisol samples. In instances where included studies were expanded or published subsequent to recruitment to this meta-analysis, the most recent reference has been used to cite the dataset used.

2.3 Quality assessment and risk of bias

The study summary template sought confirmation that animal ethics approval had been granted from the relevant research institutes. The decision to recruit only studies that had undergone the peer-review process may represent a publication bias effect (due to

the underrepresentation of insignificant results published in the scientific literature), but peer-review was considered a necessary quality assessment hurdle for study inclusion. The recruited studies all shared their raw data for the purpose of this meta-analysis, clearly describing their subject recruitment criteria, sampling materials and method, setting, and locations where data were collected. In addition, given that the breadth of recruited studies included some experimental designs posited to increase, while others were expected to decrease salivary cortisol concentration, we concluded they were all prospective studies with low risk of bias across the cumulative data.

2.4 Coding of data

Study data were coded at the individual test sample level for (1) dog breed, (2) dog age, (3) dog sex (including neuter status), (4) dog weight, (5) dog coat color, (6) dog type (purpose or role for which the dog was bred, e.g. pet, racing greyhound, military working dog, etc.), (7) regular living environment (where the dog lived in the 1 mo preceding testing), (8) social living condition (usual conspecific social living environment, e.g. individual, group, etc.), (9) testing environment, (10) presence of owner/handler during testing, (11) duration dog had spent in environment at time of testing, (12) time of testing, (13) date of testing, (14) experimental condition, (15) physical activity as part of experimental protocol, (16) physical activity in the hour prior to testing, (17) cortisol concentration value ($\mu\text{g/dL}$), (18) collection media, (19) salivary stimulant, (20) having eaten in the 3 h prior to testing, and (21) assay type (EIA/ELISA or RIA).

Due to the variability in the way recruited studies had coded their own data sets, we collapsed the raw data from some categories into groups (e.g. Dog age - Juvenile: < 12 mo of age, Adult: 1-8 yr of age, Senior: > 8 yr of age; Time of testing – 6-8 am, 8-12 pm,

12-3 pm, 3-6 pm, 6 pm - 12 am, 12-6 am) to allow for meaningful analysis. For some variables, data were grouped in up to 3 different predetermined ways to capture all recruited studies.

2.5 Statistical analyses

A linear mixed-effects regression model with a 2-level hierarchal organizational structure was fit using the maximum likelihood estimation method to determine cortisol concentration, a continuous outcome, as a function of dog characteristics, environmental factors and experimental design. The selected model controls for: (1) inter-study variance introduced by the 31 different study data sources, and (2) repeated measures introduced when data was collected from the same subjects at multiple time points.

Inter-study variance was controlled for in the model by including a level-1 random intercept of the study indicator variable. The significance of its covariance was assessed through a covariance test ($P = 0.0041$) which supported including it as a level-1 random effect in the model. A repeated measures variance-covariance component also was included in the model to account for repeated observations. The repeated measures covariance component was highly significant in the test of covariance ($P < 0.0001$), which supported retaining it in the model. The variance components covariance matrix, the default structure in Statistical Analysis Software (SAS®) PROC MIXED, was used to estimate the covariance structures for both the random study source effect matrix and the repeated measures matrix.

Next, inclusion of the covariance components in the model was assessed by comparing the final model, which controls for random effects and repeated measures to a model

that does not. The fit statistics, Akaike's Information Criterion and the Schwarz's Bayesian Information Criterion, were both smaller in the former model indicating a better fit. The independent variables were then fit as fixed effects in the model using stepwise model building methods. All the independent variables retained in the model exhibited significance in the tests of fixed effects.

Post hoc analyses were then conducted to assess the assumptions of homoscedasticity, and normality for both level-1 and level-2 residuals. The homogeneity of variance assumption was first assessed by examining the distribution of conditional residuals of the response variable *cortisol* ($\mu\text{g/dL}$) across studies, level-1 random effect, through a box-and-whisker plots panel. The residuals exhibited a similar spread across studies around a mean of zero and appear to be normally distributed. Next the distributions of the residuals for the response *cortisol* ($\mu\text{g/dL}$) were examined across all the independent variables in the model, level-2 fixed effects, whereby the residual distributions also exhibited a similar spread around a mean of zero which suggests validity of the assumptions of normality and homogeneity of variance.

As the pooled data originated from multiple studies and some shared a randomized controlled design, the final model was run on a sub-sample of control subjects to ensure that treatment effects on subjects assigned to the experimental arm are not biasing the general pooled sample estimates. The resulting estimates of the model run on the controls-only sub-sample were comparable to the estimates obtained for the general sample, which confirmed that no detectable bias was being introduced by including control and experimental subjects in the same analysis.

3. Results

3.1 Study characteristics

The systematic review of literature databases and conference proceedings from 1992-2012, identified 61 peer-reviewed studies utilizing salivary cortisol from domestic dogs, 31 of which were included in the meta-analysis as described in Figure 1. Summary characteristics for included studies are shown in Table 1. The compiled data yielded a total of 5,153 samples from 1,205 individual dogs. Sample sizes ranged from 7 to 114 dogs per study, with between 1 and 30 samples per individual dog. The frequency of sample salivary cortisol concentrations exhibited a logarithmic distribution, as shown in Figure 2.

Because the dataset included samples from a number of different study designs with some studies including stressors, some including interventions designed to decrease stress, and all occurring in a variety of environments (home vs. displaced, etc.), analyses were run on the entire dataset (5,153 observations) and on the controls only subset (3,016 observations). The findings were essentially the same. The results reported below therefore reflect the findings of the analysis using the entire dataset, with any differences between the controls and entire data set specifically pointed out.

Study	Year	N dogs (n samples)	Assay type	Dog type	Testing Environment
Batt, et al. [23]	2008	46 (187)	ELISA	Guide	Kennel (Displaced/Unfamiliar)
Belpedio, et al. [24]	2010	40 (428)	ELISA	Pet	Shelter
Bennett and Hayssen [25]	2010	48 (311)	ELISA	Pet	Residential Home
Bergamasco, et al. [26]	2010	19 (119)	RIA	Pet	Shelter
Bosch, et al. [27]	2009	70 (168)	RIA	Pet	Experimental (Novel/Unfamiliar)
Bryan, et al. [28]	2013	7 (181)	ELISA	Teaching	Experimental (Familiar)
Cobb, et al. [18]	2010	50 (276)	ELISA	Guide	Residential Home & Kennel (Displaced/ Unfamiliar)
Dalla Villa, et al. [29]	2013	17 (96)	ELISA	Pet	Shelter (Long-term)
Dreschel and Entendencia [30]	2012	14 (60)	ELISA	Narcotics detection	Work environment (Certification test)
Dreschel and Granger [8]	2005	20 (115)	ELISA	Pet	Residential Home
Dreschel and Granger [5]	2009	35 (88)	ELISA	Hunting	Kennel (Familiar)
Glenk, et al. [31]	2014	23 (114)	ELISA	Pet	Residential Home
Hekman, et al. [32]	2012	63 (63)	ELISA	Pet	Vet Hospital
Horváth, et al. [33]	2008	45 (168)	ELISA	Police & Border guard	Outdoor testing area (Familiar)
Horváth, et al. [34]	2007	60 (120)	ELISA	Police	Indoor testing area (Familiar)
Jongman, et al. [35]	2011	35 (166)	RIA	Racing (greyhound)	Kennel (Home/Familiar)
King, et al. [36]	2011	26 (150)	ELISA	Pet	Therapy Worksite (Familiar)
Ligout, et al. [37]	2010	20 (90)	ELISA	Pet	Experimental
Marinelli et al. [38]	2009	11 (21)	RIA	Pet	Experimental
Menor-Campos, et al. [39]	2011	37 (211)	ELISA	Pet	Shelter
Mongillo et al. [40]	2013	62 (336)	RIA	Pet	Experimental/Testing facility (Familiar)
Morrow, et al. [41]	2015	57 (374)	ELISA	Pet & Working Stock	Residential Home & Kennel
Ortolani, et al. [42]	2013	66 (66)	ELISA	Pet	Veterinary Practice
Ottenheimer Carrier, et al. [19]	2013	58 (58)	ELISA	Pet	Outdoor Dog Park (Familiar)
Ottenheimer Carrier, et al. [19]	2013	11 (37)	ELISA	Pet	Outdoor Dog Park (Familiar)
Phillips Buttner and Strasser [43]	2014	47 (94)	ELISA	Pet	Shelter
Schöberl, et al. [44]	2012	22 (593)	ELISA	Pet	Residential Home & Experimental
Siracusa et al. [45]	2010	46 (169)	ELISA	Pet	Shelter Hospital
Svobodová, et al. [46]	2014	9 (18)	ELISA	Police	Kennel (Home)
Walker, et al. [47]	2009	17 (17)	ELISA	Pet	Shelter & Residential Home
Yong and Ruffman [48]	2014	114 (228)	ELISA	Pet	Experimental

Table 1: Studies included in the meta-analysis (n = 31).

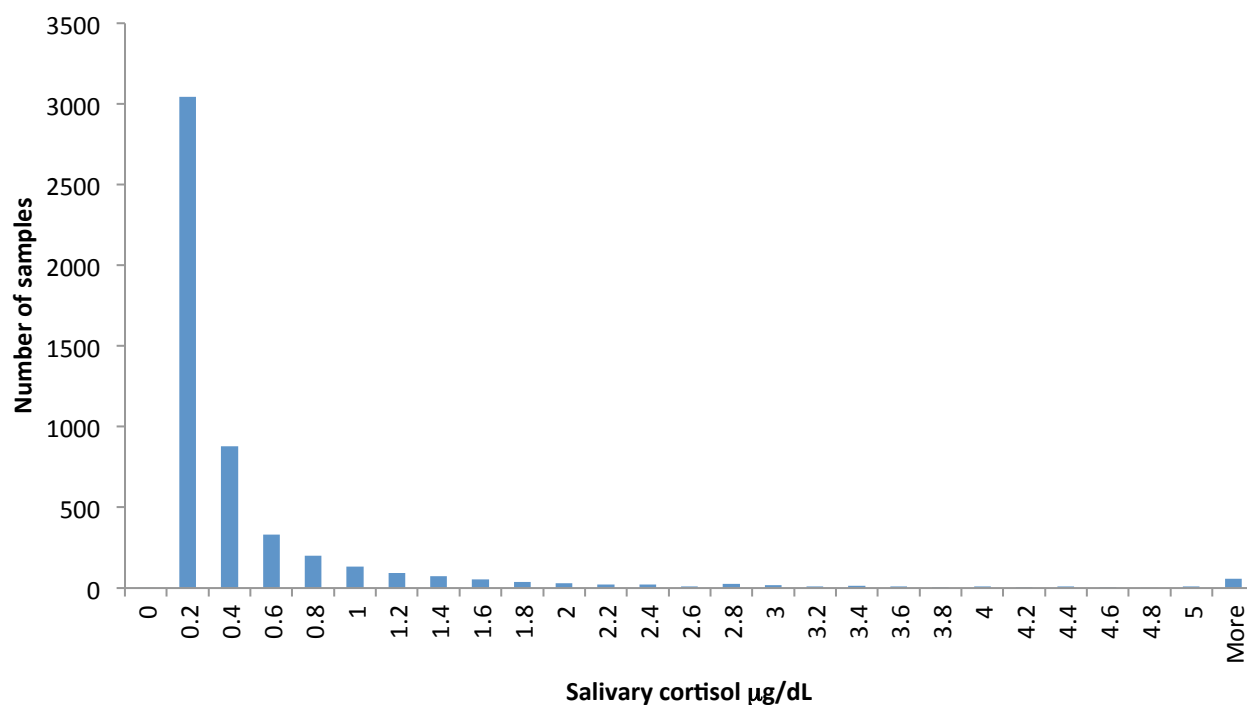


Figure 2: Frequency distribution of meta-analysis data pool of canine salivary cortisol concentrations.

3.2 Main findings

Meta-analysis using a mixed linear regression model in Statistical Analysis Software (SAS®), while controlling for random effects, inter-study variance, and intra-study repeated measures was performed. All results are expressed as µg/dL but can be converted to nmol/L by multiplying values by 27.59. Using this model, a cortisol concentration range of 0 –33.79 µg/dL was determined. The mean cortisol concentration of the pooled sample, equivalent to the intercept of the model with no predictors specified, was 0.45 µg/dL with a standard error of 0.13. The median was 0.15 µg/dL. Significant effects ($P < 0.05$) were found for a number of specific canine characteristics, environmental and experimental factors (see Table 2).

3.2.1 Canine characteristics

Intact female dogs were found to have higher cortisol concentration than neutered females, intact males, and neutered males ($P < 0.001$). Puppies less than 6 mo of age had significantly lower ($P < 0.005$) concentrations of cortisol than other age categories, including dogs 6 mo to 1 yr of age, 1-8 yr of age and > 8 yr of age.

From the available data, 131 different specific breed and breed cross combinations were coded, with many categories containing less than 5 observations. For analysis, the 7 categories that contained more than 100 observations were compared (German shepherd, Labrador retriever, Golden retriever, German shepherd mix, “Pit bull”, mixed breed, and breed not identified). No significant differences in cortisol concentration were found between these 7 breed categories that were examined. Furthermore, there were no significant effects of dog body weight, type (pet/companion, detection/military, assistance/therapy, sporting/hunting or others), or coat color on salivary cortisol concentration.

3.2.2 Environmental factors

Significant effects of regular living environment were found. Dogs living in rescue shelters for > 2 wk had lower salivary cortisol concentration than those living in working/training kennel facilities (estimate = $5.33 \mu\text{g/dL}$, $P < 0.0001$), at private residences (estimate = $4.02 \mu\text{g/dL}$, $P < 0.0005$), or those living in unknown or unreported situations (estimate = $4.05 \mu\text{g/dL}$, $P < 0.005$). There were no significant differences in overall cortisol concentration for dogs living at rescue shelters for < 2 wk, compared to those living in rescue shelters for > 2 wk. Whether dogs lived alone or with

other dogs (all, or some of the time) did not have a significant effect on salivary cortisol concentration.

The testing environment and the time spent in the living environment prior to testing also had an effect on cortisol concentration. Dogs that had spent > 14 d living in the environment prior to testing had significantly higher cortisol concentrations than those that had spent 1-9 d ($P < 0.0001$), or less than 24 h ($P < 0.0005$). Dogs that were tested in experimental environments (e.g. a laboratory, university, etc.) had higher cortisol concentrations than those tested in their regular living environment ($P < 0.01$), or in a displaced but regular living environment such as a training kennel facility or rescue shelter ($P < 0.0001$). Dogs who were away from their regular owner or handler during the testing procedure exhibited an average of 2.15 $\mu\text{g/dL}$ higher salivary cortisol concentrations than those whose owner or handler was present during the testing procedure ($P < 0.0001$).

3.2.3 Experimental design effects

A number of significant findings relate to variables surrounding the testing procedure and materials. Salivary cortisol samples collected from dogs between 6:00 am and 8:00 am were significantly lower than those collected at other time points, including 8:00 am-6:00 pm, and 6 pm-midnight ($P < 0.001$). There were no significant effects related to whether the dog had exercised or eaten within 3 h of sampling. Dogs that took part in physical activity within 1h of sampling did not show any difference in salivary cortisol concentration than dogs that did not exercise prior to sampling.

A variety of materials were used to collect saliva for cortisol determination (see Table 2). With samples collected with salivary sorbettes set as the reference, samples

collected with salivettes infused with citric acid ($P < 0.05$) and those collected with cotton pad (make-up removal style) ($P < 0.005$) had significantly higher cortisol concentrations. When media types were combined into specific materials (cotton, hydrocellulose, synthetic or other), no significant differences were noted. Interestingly, no significant difference was seen between samples collected without any type of salivary stimulant and those collected with salivary stimulants including citric acid, the smell of food, flavoring of the collection media, and giving a food treat or snack at the time of sampling. There was also no significant difference in cortisol concentrations on samples tested with radioimmunoassay (RIA) or enzyme-linked immunosorbent assays (ELISA).

4. Discussion

In our meta-analysis using raw data from 31 studies of the domestic dog, we have established a salivary cortisol concentration range of 0–33.79 $\mu\text{g/dL}$, median (0.15 $\mu\text{g/dL}$) and mean (0.45 $\mu\text{g/dL}$) values. Our main results demonstrate that domestic canine salivary cortisol concentrations are significantly related to individual dog characteristics, environmental and experimental effects. The importance of these findings is relevant to the interpretation and comparison of existing research results, and the design of future studies featuring canine salivary cortisol. This meta-analysis has confirmed that a large amount of intra- and inter-individual variability exists and that multiple external variables can influence the concentration of salivary cortisol. Consequently, care should be taken when electing to use salivary cortisol in studies of dogs at a group or population level. The results of this study suggest that salivary

cortisol concentration is not a reliable indicator of stress for canine researchers if used in isolation; caution is warranted when interpreting studies where it is the sole measure.

Our understanding of stress, the role of the HPA axis and use of the hormone cortisol as its physiological marker have grown significantly over the past half a century. Human studies offer the additional insight of subject reports relating to affect, such as perceived social and environmental stressors. While this level of direct insight into subject experience is lacking in canine studies, researchers are able to use animal behavior, personality, environment and multiple physiological measures to aid in interpreting our research. A translational approach is used in other areas of research where domestic canines act as a model for human health; for example, in the areas of cognitive decline with aging, epilepsy and cancer growth [49-51].

Human studies exploring stress physiology have led to the development of progressive theories, including the General Adaptation Syndrome [52], the allostasis models [53,54], and the U-shaped evolutionary-developmental hypothesis featuring biological sensitivity to context [55,56]. From the basis of these theories, Del Giudice and colleagues [57] developed the adaptive calibration model of stress responsivity that highlights the adaptive significance of different physiological profiles of stress responsivity.

Cortisol is a complex stress hormone, and as such, is not easy to interpret. Human psychological literature finds that declining cortisol is not necessarily good and rising cortisol is not necessarily bad [58,59]. In Shirtcliff et al [59], it is clearly illustrated that both high and low cortisol concentrations can be problematic or advantageous to humans, depending on a multitude of individual factors such as personality, timing,

context, prior stressors, and life history. The highest concentrations of basal cortisol have been found in circumstances in which people connect socially and bond. Individuals with mental health symptoms, bereaved parents and soldiers preparing for combat may demonstrate an early termination of that HPA axis that results in low basal cortisol concentrations, representing a flat-affect or emotionless response signifying physiological disengagement with social context, believed to enable people to avoid or ignore social cues in the environment [59,60]. Individual differences in stress profiles, including calibration and reactivity to unpredictability, have been shown to be influenced by relevant key life history events. To determine if a cortisol response is adaptive or maladaptive, these human studies draw on the foundations of timing, duration, context and coordination of responses across the dynamic stress regulation systems, as essential considerations [54,59,61].

The finding in this meta-analysis that intact females were found to have significantly higher salivary cortisol concentrations than neutered female, intact male and neutered male dogs was unexpected. Each of these groups comprised comparable numbers and exhibited a similar mean age. Much of the ecological research of wild canids and other social vertebrates has focused on the urinary or fecal glucocorticoid concentration differences related to social status, behavioral causes and consequences of apparent social hierarchy rank [62-64] rather than sex. Given the findings of this meta-analysis, and those from more recent research that were not included in this review [9], sex and neuter status should be considered as relevant variables in the design and analysis of future canine cortisol studies.

A limitation determining the effect of subject age was that we were bound to the categories reported in the studies recruited to the meta-analysis. In some cases, generally where precise information was not possible (such as stray dogs in shelters) dog ages were recorded only in broad undefined categories such as puppy, adult or senior. As such, only subjects for which we could confidently allocate age were included in this part of the meta-analysis ($n = 1095$).

A number of behavioral and physiological variables could affect developmental changes in reactivity of the HPA axis. A meta-analysis by Fratkin and colleagues demonstrated that stability of canine personality increases with age [65]. Perhaps as dogs age and their personalities become more established, their physiological responses to stimuli may stabilize as well. Memory retrieval in humans is known to be hampered by cortisol, even with unchallenged basal cortisol concentrations [66]. It may be relevant then that young dogs experience lower basal cortisol concentrations during their most critical learning periods in the first 6 mo of life. New data from primates also suggests an early inhibitory effect of the amygdala on HPA activity during early development, and lends credence to proposed 'developmental switches' relating to amygdala function and brain connectivity [67]. Given the significance of age in this meta-analysis, subject age should always be recorded and considered as a variable in future analyses. Ideally, cortisol concentrations of dogs under the age of 6 mo should not be pooled or directly compared to those of older dogs without acknowledgement that this has been done.

This meta-analysis found no significant differences in salivary cortisol concentrations related to other dog characteristics such as breed, coat color,

bodyweight or role of the dog (e.g. companion pet versus military working dog). We investigated these characteristics as many studies focus on only a single breed or type (i.e. pet, military police or guide dog, etc.) of dog and this meta-analysis provided a unique opportunity to explore these areas of variation that could underlie hypotheses relating to canine salivary cortisol concentration. In some cases, such as stray dogs in shelters, it was not possible to collect information about the dog's original role. Most of the studies included in this meta-analysis had not recorded coat color or body weight data. Given this limitation, and that recent research suggests that size can be significant [9], we recommend that these variables be recorded in future study design and analysis as potentially relevant factors.

Dogs living in shelters exhibited salivary cortisol concentrations significantly lower than those living in private residences or working dog kennel facilities. This unexpected finding may suggest exhaustion dysregulation of the HPA axis, resulting in depressed cortisol output. HPA hypoactivity such as this has been found in humans, arising through chronic stress, sleep disturbances and subsequent excess fatigue [68,69]. This state, known as 'vital exhaustion' is reportedly accompanied by feelings of increased irritability and demoralization that individual people reach when they feel no longer able to cope with chronic life stressors (e.g. prolonged work overload, financial problems). Repeated social regroupings have been shown to induce a chronic stress state in pigs [70]. It is therefore probable that the social and environmental challenges for dogs who have been displaced into a shelter environment may result in the observed HPA hypoactivity or dysregulation. However, even dogs living in shelters for less than 14 d had significantly lower values than the others. Because cortisol concentration is frequently used as a sole factor of HPA functioning in canine studies, we are unable to

measure the integrity of the cortisol responses. Hennessy [71] recognized that cortisol concentration may be better used for measuring a short term response to intervention, rather than ongoing effects in a chronic stress situation.

Independent of the type of living environment, the duration that dogs had spent in that environment prior to testing was significant. Dogs who had been in the living environment for less than 4d demonstrated salivary cortisol concentrations that were significantly lower than those who had been there for more than 2 wk. Dogs who had been in the living environment for 5-9 d were also significantly different to those who had been in > 2 wk, but estimates were less disparate than the 1-4 d and < 24 h categories. The variability in these responses is an example of the difficulty in comparing overall study responses, if these details are not included in reports.

When dogs were tested in their normal/regular or a displaced (such as a shelter) environment, their salivary results were significantly different from those tested in an experimental setting (such as a university testing setting). This may be due to the novelty of the environment or related to the travel prior to arrival at the experimental location. This '*arrival effect*' has been observed in human studies when subjects arrive at a laboratory and also in situations where experimenters arrive at a subject's home. This effect is routinely minimized for humans by inclusion of a 30 min interval factored into the experimental design [59]. This is an important consideration for future study design to ensure that salivary cortisol sampling is testing the effect of the study question rather than reflecting the response to car travel or a novel environment. Without being able to predict if individual dogs would calm down or get more excited by interval

inclusion as per human experimental design, ensuring baseline samples are taken from the usual environment appears prudent.

Time of day and influence of circadian/diurnal rhythm on salivary cortisol concentration is a key consideration in the design of studies using cortisol. The analysis of sampling time effect was limited by the raw data collected in recruited studies. Similarly, other variables of interest within the scope of this meta-analysis (e.g. sex of owner/handler/researcher; temperature; season; photoperiod; latitude) were not available. The lack of uniformity in this area across studies meant an accurate assessment of a 24 h pattern in canine salivary cortisol concentrations could not be made. Within the constraints of the available groupings, samples collected between 6-8 am were found to be significantly lower than those collected between 8 am and midnight. Other social mammal species, such as humans and rodents, demonstrate a cortisol awakening response, a rapid increase in cortisol secretion within the first 45 min following morning awakening [72,73]. However, the presence of a similar awakening response has not yet been identified in dogs. The sleep-wake cycle of dogs is different to that of people and rodents (Miyazaki et al, 2008). As such, their sleep patterns and cortisol awakening response vary and may also be influenced by environment and daily management (Campbell & Tobler 1984; Anderson et al, 1990). For example, they may sleep more when housed in a deprived environment such as a kennel facility if experiencing affect consistent with a depressive state, or they may sleep less due to the disruptive noise of other dogs barking (Gunter, et al, 2019).

We advise that future studies should aim to collect saliva from subjects at a consistent time that is reported in the experimental methodology, and care should be taken in pooling or comparing data from dogs, or between studies, where collection times vary.

The secure base effect component of the attachment system, known to exist between human children and their primary caregiver, has been demonstrated in dogs during cognitive testing [74,75]. The finding from this meta-analysis that dogs who had their owners or regular handlers present had significantly lower salivary cortisol concentrations than those who did not, adds credence to the important implication the presence of primary caregivers might have during a behavioral or physiological test situation. For this reason, future study designs should consider this factor and document primary caregiver presence or absence at time of testing in reports. In addition, recent research has also demonstrated a significant physiological stress response related to sex of experimenters in laboratory-based rodent studies [76]. The implications of this on canine studies could be substantial. For this reason, the sex of researchers directly involved in handling and sampling dogs should be recorded in future studies. In studies where repeated sampling encounters occur, experimenters collecting salivary cortisol may start as unfamiliar but become familiar over time, possibly influencing results (Lore & Eisenberg, 1986; Wells & Hepper, 1999; Pullen et al, 2012).

A wide variety of methods are used to collect salivary samples for cortisol concentration analysis. Samples collected with salivettes that were infused with citric acid showed significantly higher cortisol concentrations than those collected with most other materials. Citric acid use in human sampling has been shown to artificially increase the concentration of cortisol in human saliva, likely related to an increase in sample acidity

[77]. Samples collected with cotton pads (make-up removal type) also had significantly higher cortisol concentration. It is important that researchers understand the importance of collection materials and are clear in their reporting of these materials. While no difference was seen in salivary cortisol concentration values between samples collected using other cotton materials (eg. Dental ropes, cotton balls, cotton swabs, etc.) and hydrocellulose materials (e.g. micro-sponges, Salimetrics children's sponges, etc.), there is evidence that sample collection materials and volume of sample collected can influence cortisol concentration and other hormone assays in humans [77]. As manufacturers change the names of collection devices, it becomes imperative that the actual material used to collect saliva is recorded. For example, Salivettes™ can be ordered with either a cotton swab, a cotton swab with citric acid, or a biocompatible synthetic swab. New absorptive collection materials should be tested for interference with the cortisol assay before using in a study [5]. While no significant difference was seen between samples collected without salivary stimulants and those collected with salivary stimulants, it is recommended that researchers note the use of these in their collection protocols. Stimulants that involve putting additional materials (e.g. flavorings, citric acid, etc.) directly in the mouth are thought to be more likely to cause unpredictable interference effects. However, the smell of food, and conditioning dogs to be familiar with having their mouths handled may result in less testing interference.

In the search to better understand the experience of dogs, canine researchers should consider extending beyond reporting only group means, and the inevitable issues posed by consistent inter- and intra-individual variation, by analyzing the data in a way that reflects these differences [78]. Human health research methodology has much to offer in this domain [79]. While population means may not give the best insight into animal

welfare or stress experiences, the use of trajectory modeling of multiple physiology measures in conjunction with behavior observations or assessment offers a new way to explore the experience and ways that dogs cope in stressful situations [80]. Group based trajectory modeling and analysis might offer better insight to the individual dog experience, different coping styles, and trends within groups.

We acknowledge several limitations of this systematic review and meta-analysis. This was an exploratory meta-analysis framed around key questions relative to the use of salivary cortisol in canine studies. Data from earlier studies that could not be located or sourced as they pre-dated the ease of data transfer and archiving so readily available today were not included. This possibly biases the results and prevented this study from testing for an effect improving assay technology. For example, improved assay efficacy over the last three decades, or changed reference ranges in samples compared between older and more recent testing techniques.

Some of the analyses were limited by the way data had been categorized by contributing studies (e.g. time of day; age of dogs). Researchers did not always record or retain precise values, and so the data were coded and analyses run within the grouped data variables available. Similarly, other variables of interest within the scope of this meta-analysis (e.g. sex of owner/handler/researcher; temperature) were not available. This could be relevant to results and should be considered in the design of future studies given recent findings [76] and those of past canine studies [81].

The studies included in this meta-analysis were of mixed designs with highly varied purposes. Some studies were seeking to increase stress, some to ameliorate situations considered stressful, while others assessed stress encountered as part of routine

activities. These studies, and consequently this meta-analysis, were not uniform in considering just baseline concentrations of salivary cortisol, or measures of heightened or lowered reactivity. Although this study did test a sub-sample of control-only data against the full data set and found no significant differences in results, it is worthwhile emphasizing that this exploratory meta-analysis was not specifically looking to assess a response to any specific stressor or protocol.

5. Conclusions

In conclusion, this meta-analysis highlights the importance of carefully planning and controlling experimental design in addition to recording subject, experimenter and environmental factors in order to compare salivary cortisol concentrations within and between individual dogs. Caution should be exercised in comparing different studies using salivary cortisol concentration as a measure, as the results could be a reflection of a plethora of factors. In humans, much research has been done to evaluate the effects of physiological and psychological stressors on HPA axis activation. Challenges requiring extensive, sustained mobilization of metabolic and psychological resources are most likely to activate the HPA axis. The largest cortisol concentration increases are seen when both social-evaluative threats and uncontrollable outcomes are present. How these constructs apply to canines, and how this affects our interpretation of animal welfare, may have interesting implications for future directions in canine research.

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7. Author Contributions

Conceived and designed the study: MLC, NAD. Collected the data: MLC, NAD. Analyzed the data: KI, VMC. Wrote the manuscript: MLC, NAD. Contributed to manuscript revision: MLC, NAD, KI, VMC.

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Chapter 8

General discussion

General discussion

The welfare of working dogs is important for a variety of reasons. Clearly it is important to the individual dogs as sentient animals. As my research shows (see Chapter 3), the welfare of working dogs is also very important to members of the public who provide a social licence for working dog industries to operate. The welfare of working dogs is also critical to their performance in tasks serving people, and fundamental to the sustainability of utilising dogs in these roles. The aim of this thesis was to advance the welfare of working dogs by examining human attitudes and canine responses to kennel management practices relevant to the welfare and performance of working dogs.

In this concluding chapter, I summarise and discuss the implications of the collective findings of this interdisciplinary body of research. I also discuss the impact for research on working dog welfare and outline potential directions for future research. Continued research into the welfare of working dogs will help align industry practices with wider societal standards. Collectively, the findings presented in this thesis make a meaningful contribution toward advancing the welfare of working dogs; highlighting the ways that working dog industry members, government and scientists can contribute to sustaining public confidence in working dog welfare and an ongoing social licence to operate.

1. Main Findings and implications

The studies described in this thesis clearly demonstrated that the welfare of working dogs is an important issue for the consideration of all working dog industry stakeholders. This includes working dog industry workers, facility and dog owners, sporting clubs,

financial sponsors, the general public, the government, and scientific researchers. The continued sustainability of utilising dogs in working roles critically depends on the transparency, accountability and public assurance of good welfare for working dogs. Below I discuss how the findings of this thesis may support this outcome.

1.1 The welfare of dogs is important to people

Community attitudes play a critical role in directing societal expectations. These expectations can have an important influence on government and industry regulations, determining the standards of care for animals such as working dogs [1, 2]. The complex and multi-dimensional nature of public beliefs toward dog welfare was explored in Chapter 3. This research demonstrated for the first time how the perceived welfare of one species found in a variety of working, companion and wild contexts can vary widely, from extremely poor to extremely high. The vast majority of survey respondents identified that the welfare of dogs was very important to them. This highlights the significance of perceived welfare issues at a societal level and flags the potential for industry disruption if public expectations are not met, as indicated in Chapters 2 and 3.

What people perceived to be most important to the welfare of dogs living in kennel facilities varied between industry roles, which may contribute to occupational stress and staff turnover (Chapter 4). Having been overlooked previously, the insights into the perceived importance of kennel management practices provided in Chapter 4 represent a unique contribution to improving the welfare of dogs housed in kennel facilities. The beliefs, attitudes and consequent behaviours of people working in these roles directly impacts upon the experiences and welfare of the resident dogs. As an initial examination, this study provides a foundation for future research to understand

how these beliefs are developed, what informs them and how they may be influenced to improve dog welfare and performance.

Regulatory standards of care do not currently provide reliable assurance to the general public that working dogs housed in kennel facilities will be given the resources necessary to ensure their physical and mental wellbeing (Chapter 4). Government can improve the welfare of working dogs by ensuring that legislation applies to all kennel facilities, without exemption for non-commercial working dog kennel facilities. Models of animal welfare should include human-animal interaction, as identified in Chapter 4, and should inform standards of care that include positive welfare states for captive animals held by people. Opportunity now exists to update existing models and policy, which would enable working dog industries to meet modern community expectations.

1.2 The transition to living in kennel facilities is stressful for young working dogs

Current inefficiencies throughout the working dog life cycle are contributing to high wastage, with economic consequences to working dog industry groups (see Chapter 2). For example, young working dogs were shown to experience stress when transitioning to living in a training kennel facility (Chapter 5). This transition occurs at a critical time when dogs are being assessed to determine if they will commence the formal training program. The population of dogs studied in Chapters 5 and 6 had prior familiarisation experience with the kennel facility [3] and were widely socialised to a range of people and places during puppyhood [4]. However, three measures of physiological stress provided robust evidence that the first two weeks living in kennels are distressing (Chapter 4). This stress has the potential to undermine the ability of the dogs to learn and perform optimally.

Distress has been shown to inhibit learning and memory retrieval, resulting in reduced performance, particularly in unfamiliar environments [5, 6]. The stress encountered by young working dogs may be impacting their ability to pass assessment and enter the formal training program, as shown in Chapter 6. This not only impacts upon the efficiency and cost-effectiveness of the working dog program, but also poses a risk to public perception if the program is perceived to discard young working dogs following industry-imposed stress. The working dog industry will need to do more, and visibly, to reduce the stress experienced by working dogs living in kennel facilities if they wish to retain public goodwill toward the utilisation of dogs in working roles. This will likely provide the additional benefit of reduced wastage, improved cost effectiveness for programs and optimised learning and operational performance in working dogs.

Consultation with working dog industry members revealed concerns that enrichment in kennel management practices may increase stress or negatively influence training outcomes (Chapter 4). However, as shown in Chapter 6, the implementation of a composite enrichment program did not significantly increase physiological stress as some feared. Enrichment may play a role in helping young working dogs cope with the transition to living in a kennel facility, but more research is required as the relationship between enrichment, stress and performance is not simple or well understood. Future research is needed to determine which combination of enrichment activities optimally improves dog welfare. It is likely that an individualised approach to enrichment practices, incorporating behavioural observations, will be required to best support the

transition of social and physical environment and optimise performance outcomes in young working dogs housed in a kennel facility.

1.3 More meaningful measurement of physiological stress is required

Physiological measures, such as those examined in Chapters 5 and 6, are widely used by researchers to quantify stress responses. Salivary cortisol is one of the most commonly used physiological markers in canine studies over the last decade, but is often used as a sole measure of physiological stress. Many basic features of salivary cortisol were unknown. The systematic review and meta-analysis presented in Chapter 7 sought to address this existing gap. The pooled raw data from over thirty studies allowed, for the first time, meaningful identification of important features of this widely used marker, including its natural range and the effects on salivary cortisol concentration related to dogs, the living environment and experimental design (Chapter 7). Having identified the many features that can impact salivary cortisol concentration has enabled careful interpretation of existing results and will inform the design of future research utilising salivary cortisol in studies of domestic dog welfare.

Scientists can also improve the way that physiological stress is measured and described to overcome the continual reporting of inter- and intra-individual variation as a limitation of the findings. As described in Chapters 6 and 7, the use of group-based trajectory modelling offers a more meaningful way to interpret stress marker results than group means, although this may not be feasible in studies where sample sizes are small.

The use of multiple measures will also improve the interpretation of physiological markers of stress. The discovery of a single physical marker that can be used as an indicator of animal welfare remains unlikely. Salivary cortisol appears unsuitable for use as a single measure in studies of physiological stress in dogs, despite being commonly used as such. Using multiple, minimally invasive markers to provide insight into HPA-axis and immunological response over short and long periods is current best practice in canine science. Although not feasible for inclusion in this thesis, I recognise that the findings of these studies would have been significantly strengthened by the inclusion of behavioural observations of the dogs in the kennel facility. Activity budgets for the dogs housed in the kennel facility and measurement of behaviours known to correlate with stress (such as paw lifting, coprophagy, vocalising, lip licking and yawning [7-9]) would have provided a richer interpretation of the physiological data. Consideration of how dogs in the enrichment group interacted with and utilised enrichment opportunities, and whether this influenced the style of inter- and intra-specific social interactions, would have further informed how enrichment-related kennel management practices effect the welfare of working dogs transitioning to kennel facilities.

1.4 Science can help improve the welfare of working dogs, but we need to do more

Scientific information needs to be readily accessible to compete with other information reaching working dog industry stakeholders, as outlined in Chapter 2. Meaningful engagement and improved community outreach by researchers is needed to improve the uptake of research findings into evidence-based best practice (Chapter 4). The

knowledge deficit model of science communication traditionally used by scientists has been shown to be less effective than alternative approaches that draw on the social sciences, such as participatory and community-based approaches [10]. This is particularly true in morally contentious areas such as the care and welfare of working dogs. When consulted, working dog industry workers felt that scientists were not asking the questions they believed to be most important to industry. This is critical as research is limited by restricted access to working dog populations, and failure to win the trust of the industry may compound this.

Researcher access to working dog kennel facilities is limited and study cohorts are often small, as evidenced by other research in this domain. There are few opportunities for experimental manipulation: kennel management practices and training programs are generally well established and successful dogs are required to meet business requirements. This reluctance to change practices or participate in research, is seen in other areas where investment takes place over an extended time and the end product has high value, such as water and crop management in Southern Africa, and the low rate of involvement of pregnant women in research [11, 12]. Langston [12] notes that “the role of industries in generating, shaping, and reinforcing norms, in addition to producing products, is often overlooked”. In the non-profit sector particularly, where resources are limited, this results in experimental change being viewed as a risk to the success of the program. The tendency for risk-adverse industry groups to favour inaction highlights the need for more effective communication strategies between all working dog industry stakeholders if a sustainable outcome is to be achieved. A participatory, community-based research approach where industry representatives and researchers

come together to formulate and answer questions of mutual interest is most likely to result in collaboration that fosters a shared purpose, improving uptake of research findings into evidence-based best practice [11, 13]. Similar strategies in agricultural contexts found the participatory process gave farmers the analytical tools they needed to think critically and make informed decisions, improving their confidence when explaining the function of innovations to others and the desire to engage in sustainable change [11]. This could be achieved by means of workshops to develop a schedule of research initiatives that are publicly or government funded to better engage scientific researchers with the working dog industry to demonstrate the mutual benefits of collaboration.

2. Future considerations and research limitations

The data presented in this thesis were collected ten years prior to submission. Although this represents a clear limitation of the findings, it does not deter from the novelty and significance of the key results. It also reflects the paucity of research being conducted in this area and the need for greater research to better understand working dog welfare and to implement this research in practice. Repeating the surveys now would offer good insight into the stability of beliefs and attitudes toward canine welfare and the importance of kennel management practices over time. This would be particularly interesting in light of recent media coverage of welfare issues relating to greyhound racing and pedigree dog breeding.

The provision of enrichment is important to primary care givers in a kennel facility workplace (Chapter 4). It would have been useful to examine the attitudes of the workers in the kennel facility studied in Chapters 5 and 6 towards animal welfare and kennel management practices such as enrichment. It was beyond the scope of the current study and was not ethically feasible as I was employed as the kennel facility manager and the primary care staff were my direct reports. It is possible that people providing care to working dogs are influenced by the provision of kennel facility enrichment activities. If this is reflected through changes in their care giving behaviours, enrichment programs may indirectly influence canine welfare by influencing the behaviour of human care givers.

Future assessment of composite enrichment programs and individualised programs of enrichment must include cost effectiveness and implementation feasibility for kennel facility staff members. As my research shows in Chapter 6, more of the dogs that had access to the enrichment program ended up qualifying as operational working or breeding dogs. Over the 18 month duration of these studies, this difference was five more dogs compared to the control group. Given the financial investment to get these dogs to the assessment stage at 14 months of age (estimated at around AU\$15,000; US\$10,500; £8,500), investment in additional staff and enrichment resources to enable kennel enrichment programs, compared to the wastage of dogs not coping when stressed in kennels, may be worthy of further cost-benefit analysis to enable organisation to understand the economic and operational benefits. It is possible that breed and sex differences may play a critical role in kennel distress and how effective

enrichment programs can be. This was beyond the focus of the current study but would be an interesting next step for consideration.

Since this thesis began, the field of canine science has grown, including an increased understanding of the rich social and affective lives of dogs. In considering the transition of young dogs into kennel facilities, enrichment often focuses on changes to the environment. However, the impact of change in the social lives of young dogs during this period has not been examined closely. I believe the role of attachment will be an important consideration to the welfare of future working dogs. In programs where dogs are raised under close human supervision, such as in breeding centres and puppy raising programs, dogs are rarely away from their human caretakers, forging a strong attachment to humans. We do not adequately understand how the disruption and transfer of canine attachment to humans across their lifetime impacts the affective state of working dogs and their consequent ability to learn and perform in working roles. Given the significance of primary caretaker presence to salivary cortisol concentration identified in the salivary cortisol meta-analysis in Chapter 7, I suspect the change in social environment is at least as stressful to young working dogs as the change in physical environment when transitioning to kennel facilities.

There is a growing body of evidence demonstrating the existence of different attachment styles and occurrence of both separation anxiety and the secure base effect in canine attachment to humans [14-16]. Early studies have not been able to differentiate significant differences between companion and working dogs in attachment styles [17]. However, a study by Wanser and Udell [18] showed that dogs with an insecure attachment style gazed at handlers more frequently during animal

assisted therapy sessions. Directed gaze toward humans in dogs has been proposed as a coping strategy on the basis that dogs may find visual reassurance of their handlers presence intrinsically rewarding [19]. Future research should investigate the role of attachment in working dogs; focusing on its relationship to stress and learning when disrupted, to inform how the working industry can facilitate optimal transfer of attachment from puppy raiser, to trainer, to operational handler. Ideally, this would also include a dyadic approach that further investigates the concurrent human care-giving strategies [20, 21], noting that training methods are also likely to impact the quality of learning and dog-handler relationship.

The significance of attachment is particularly pertinent to the manner in which working dogs are managed once operational. Despite research showing that working dogs housed with handlers demonstrate less behavior indicative of impaired welfare [22], recent trends have seen government working dog programs move away from single dog-handler dyads where dogs reside in handler homes, largely due to the costs of overtime and insurance. This has resulted in larger numbers of dogs being housed in central kennel facilities. The cost effectiveness of these programs has also meant dogs are expected to be worked by multiple handlers, improving operational flexibility when handlers are on leave, or sick [23]. Attachment to handlers has been shown to impact canine performance [22, 24], as acknowledged by working dog handlers reporting to me that dogs can operate very differently with different handlers. For example, a dog may perform a scent detection task with higher accuracy for their primary handler, but with reduced accuracy for a secondary or tertiary handler. Understanding the role of attachment in working dog performance, and how it may relate to stress and coping for

dogs housed in kennel facilities, would raise standards of care and operational practices that improve program cost effectiveness, dog performance and the welfare of working dogs.

3. Conclusion

Working dogs play a critical role in society and are fundamental to many industries and people's wellbeing. If we are to continue to enjoy the benefit of working dogs we need to ensure they are treated well. The transition to living in kennels has been shown to be stressful at a time most likely to impact working dog program success. Further research is required to understand the ways enrichment programs can support young working dogs living in kennel facilities. This thesis has made novel and significant contributions to advance the welfare of working dogs by expanding our knowledge and understanding of human attitudes and canine responses to kennel management practices. I have highlighted the ways that working dog industry members, government and scientists can contribute to a sustainable public confidence in working dog welfare and ongoing social licence to operate. The welfare of dogs is important to people and transparent assurance of the welfare of working dogs will be inherent to the future sustainability of our society utilising dogs in this way.

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