Management and Personality in Labrador Retriever dogs

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Abstract

Canine personality is of keen interest to dog owners and researchers alike. The regular human contact with them makes dogs an ideal species to use in the investigation of animal personality. This study specifically focused on Labrador Retrievers, consistently one of the most popular breeds both in the UK and around the world. Using surveys completed by dog owners, data was gathered on the behaviour of the dogs, in addition to the physical characteristics and management characteristics of the dogs (n=1978). Twelve personality traits were identified and investigated for associations with the demographic data. It was found that the working status of the dog was more commonly associated with differences in personality than other analyzed factors. Gundogs had higher scores for 'fetching tendency' and 'trainability' than Showdogs or Pets ($P<0.05$). Chocolate dogs were more 'agitated when ignored' and showed more 'excitability' than black dogs, and lower 'trainability' and 'noise fear' than both yellow and black dogs (all $P<0.05$). Dogs exercised for longer periods showed less aggression, less fear of humans and objects and lower separation anxiety than dogs that were not as active. The effects observed in this study may be due to the experience and training of the dogs, the work-related genetic strain of Labrador Retriever or most likely, a combination of both influences.

Keywords: Labrador Retriever, Management, Personality, Demographics, C-BARQ, canine

1. Introduction

It is commonly observed that individual animals show consistency in the way they respond to situations, and that the intensity of the response varies between individuals. In farm animals this phenomenon is termed temperament (Burrow and Corbet, 2000, Hoppe *et al.,* 2010). However, in dogs it is often called personality (Svartberg *et al.* 2005, Ley *et al.,* 2008), and this is the convention that we will follow for this paper.

An animal's personality arises from the influences of both genetics and its environment, including previous experience. Prenatal experience has been shown to have long term effects on personality and other traits. Zebra finch eggs injected with testosterone produced birds that habituated quicker to novel food (Tobler and Sandell, 2007). Sows born to mothers that experienced social stress during pregnancy show more restlessness and aggression toward their own piglets (Jarvis, *et al.,* 2006). There are also many postnatal influences that determine an animal's personality. Critical periods in early life are known to affect the long-term behaviour of the dog (Scott and Marston, 1950). The time at which a puppy is introduced to humans is critical, with earlier introduction resulting in more positive reactions towards humans in adulthood (Freedman *el al.,* 1961). Svartberg *et al.* (2005) also found that dogs' reactions to some tests changed following later repetition, such as tests intended to provoke aggression using unusual stimuli. Although the individual dogs' reactions changed, the relative ranking of the dogs remained the same. Since personality is unique to each individual animal, it can be influenced by other factors and experiences in the animals' life history. Kutsumi *et al.,* (2013) found that puppy training classes improved long term obedience as well as response to strangers. McMillan *et al.,* (2013) found that puppies obtained from pet stores scored less favorably on a personality assessment than

puppies from non-commercial breeders, such that pet store dogs showed higher aggression and separation-related problems than dogs purchased from breeders. Later retesting produced similar results, showing that early experience has a long-term effect on the personality of the dogs.

The genetic influence on animal personality has often been studied in terms of breed differences. Differences in temperament were found between breeds of cattle which were raised in identical environments (Hoppe *et al.,* 2010). These differences are presumably due to genetic differences, since other variation had been removed. Dog breeds are well known to show differences in personality (Hart and Hart, 1995). Dachshunds and Chihuahuas have shown higher aggression toward humans, while Akitas and Pit Bull Terriers show higher dog-directed aggression (Duffy *et al.*, 2008). Personality traits, including aggression, have also been shown to be heritable in dogs in a number of studies (Liinamo *et al.*, 2007; Mackenzie, *et al.,* 1986; Goddard and Beilharz, 1983; Saetre *et al.*, 2006), which could have implications for breeding programmes. This is especially true for working dogs, since an appropriate personality is important to fulfilling their duties. Additionally, Svartberg *et al.*, (2006) found that recent selection pressures have affected personality, with personality being more highly correlated with the current role of the dogs than with the breed's original purpose. For instance, breeds that are currently popular as house pets show higher playfulness regardless of the breeds' original purpose. The same experience is likely to affect genetically different individuals in different ways (Stamps and Groothius, 2010).

As personality traits have been shown to be influenced by both genetic and non-genetic ('environmental') factors, it is of interest to determine the relative importance of these different factors. In this case, ‘environment’ is defined as the management and

housing conditions experienced by domestic dogs. ‘Physical’ traits, such as age, sex and bodyweight, are also likely to influence personality. Therefore the aim of this study was to determine how personality traits are affected by physical and management factors in dogs. In order to account for the complexity of the study a large sample size was needed. In order to accomplish this, surveys were sent to several thousand dog owners. The Canine Behaviour and Research Questionnaire (C-BARQ), developed at the University of Pennsylvania, was used for this study (http://vetapps.vet.upenn.edu/cbarq/). Originally developed as a method for evaluating and predicting the success of guide dogs (Serpell and Hsu, 2001), this survey can be filled out by any dog owner. It covers many behavioural responses which are categorized into different aspects of animal personality. The survey responses are recorded on a 1 to 5 scale of the intensity of behavioural response to various situations. This is very similar to the approach of Svartberg and Forkman (2002), except the ratings are made by owners instead of a separate observer, and the behaviours recorded are elicited by normal interactions instead of induced by the test setup. The C-BARQ has been translated and used successfully in Japan (Nagasawa, *et al.*, 2011*)*, Taiwan (Hsu and Sun, 2010), and the Netherlands (van den Berg *et al.*, 2006), further demonstrating its generality. It has been used in the past to identify problematic behaviours being exhibited by individual dogs (Hsu and Serpell, 2003). It has also been used to study variation in specific traits among dogs. Using the C-BARQ, Duffy *et al.*, (2008) found that levels of aggression towards people versus aggression towards dogs varies within and between breeds.

For this study the issue of between-breed variation was eliminated by only studying a single breed, Labrador Retrievers registered with the UK Kennel Club. The overall aim of

the study was to test for associations between the animal's physical characteristics, lifestyle, potential genetic differences, and personality.

2. Materials and Methods

2.1. Surveys

A survey was created to gather demographic and management data on the dogs participating in a larger study investigating the factors associated with canine hip dysplasia. It included 38 questions on physical traits such as weight, coat colour and health, as well as management data related to activities, housing, management and feeding (further details given below).

The C-BARQ questionnaire consists of 102 questions pertaining to dog behaviour, divided into seven sections. The sections pertain to Training and obedience (8 questions), Aggression (25), Fear and anxiety (19), Separation-related behaviour (8), Excitability (6), Attachment and attention seeking (6), and Miscellaneous (Barking, chasing, unusual behaviours, etc.) (28).

The demographic survey was sent by the UK Kennel Club to the owners of 12,408 registered Labrador Retrievers which had known hip scores. Of these, 3071 surveys were completed and returned. The Canine Behavioural Assessment and Research Questionnaire (C-BARQ) surveys were distributed to the 2974 of those who had completed the first survey and also agreed to take part in the personality assessment. C-BARQ surveys were received for 2020 dogs.

2.2. Personality trait analysis

C-BARQ responses were recorded as letters A-E, with A representing a low or infrequent display of the behaviour in question, and E representing a high or frequent response. The C-BARQ data was transformed to numerical values, with A=1, B=2, C=3, D=4, E=5, and non-responses (N/A or Unanswered). Histograms were plotted for each question which were used to examine response variation for each question. Values for questions 6-8 (regarding disobedience) were reversed so 'desirable' was represented by a high score and 'undesirable' by a low score to be consistent with the other questions in that section. A description of the seven categories of behaviour are shown in Table 1.

In order to define distinct personality traits, we investigated whether some of the questions referred to the same or closely related behavioural characteristics. A Principle Components Analysis (PCA) for correlation was run in Minitab 16 (Minitab Inc.) to determine whether the answers to individual questions related to each other. Questions with 100 or more missing values were removed from analysis. This included questions 23, 32-36, 42, 50, 66, 71, 79, 87, and 103. These questions largely concerned multi-dog households or other situations that many owners and dogs had never been exposed to. Surveys missing any responses from the remaining questions were removed due to the constraints of the PCA. This resulted in a final sample size of 1077 surveys covering 89 questions. The first three components of the PCA accounted for 13%, 6.6%, and 3.9% of the variation, respectively. On the basis of the clustering of the question level traits (Figure 1), they were combined into 'personality traits' by taking the mean of the responses to questions within each PCA-defined group of traits, with the added constraint that the questions were from the same category in the C-BARQ questionnaire (Hsu & Serpell, 2003; http://vetapps.vet.upenn.edu/cbarq/). For example, the trait of Owner aggression was

calculated by averaging the values of all the questions that pertained to aggressive behaviour directed at the owner of the dog (Questions 10,14,15,18,20,26,31). Urinating/defecating was removed due to very low variation (all dogs had low scores). The correlations between the 18 remaining personality traits (Supplementary Table 1) were then calculated with the aim of further combining highly correlated traits (>0.4), again with the constraint that the questions were from the same category in the questionnaire (Supplementary Table 2). All questions included in the highly correlated traits were averaged to create the new trait in the same process as described above. If a survey had missing values for more than half the questions used to make up a personality trait, that individual did not receive a value for that trait.

This analysis resulted in a final group of 12 personality traits: Agitated when Ignored, Attention Seeking, Barking Tendency, Excitability, Fetching, Human and Object Fear, Noise Fear, Non-Owner Aggression, Owner Aggression, Separation Anxiety, Trainability, and Unusual Behaviour (Supplementary Table 3).

2.3. Management/Physical Traits

Following a quality control procedure to remove questionnaires missing key data, complete C-BARQ surveys and management and physical characteristics data were available for 1978 dogs. Age at the time of survey completion was calculated from the date of birth and the survey received date. Age was then rounded to the nearest 0.5 years. Dogs were aged between 2 and 9.5 years. Measurements made in Imperial units were converted to SI units. Body mass index (BMI) was calculated as Girth divided by Length squared. Dogs were separated into categories based on their Working Status. These categories were

Pets, Gundogs, and Showdogs. Dogs that were reported as 'Other' were either reassigned based on information provided in the comments or removed, resulting in a final sample size of 1,978. Dogs that were reported as being both Pets and Gundogs were classified as Gundogs, while dogs classified as Showdogs and Pets were grouped with Showdogs. Dogs were classified as living Indoor, Outdoor, or Indoor/Outdoor based on where they were reported to spend most of their time throughout the year. For instance, if a dog spent most of its time in a run, outdoor kennel, or yard, it was classified as Outdoor. If it spent most of its time in a house or garage, it was classified as Indoor. Dogs that were classified as Indoor for one half of the year and Outdoor for the other comprise the Indoor/Outdoor category. Gender Status was used to combine the Gender and Neuter responses. This resulted in four possible categories: Entire Males (EM) for uncastrated dogs, Entire Females (EF) for unneutered bitches, Neutered Males (NM) for castrated dogs, and Neutered Females (NF) for neutered bitches. Coat Colour was limited to the three main colours of Black, Chocolate, and Yellow. The small number of dogs that reported a coat colour of Fox Red (5), Liver (17), or Black and Tan (2) were grouped with the three categories Yellow, Chocolate, and Black, respectively. Health Status was determined by the presence of a disease or veterinary condition, with dogs either identifying as healthy (0) or having a significant health problem (1). No single health problem occurred with high enough frequency to be examined independently. Exercise was categorized into 1 (up to one hour per day), 2 (1-2 hours), 3 (2-4 hours), or 4 (more than 4 hours).

Sire ID was used to identify full or half siblings and was used to account for any variation due to family relationships. Of the study dogs, 693 had sires which had no other progeny in our study. The remaining 1285 dogs had sires that had between 2 and 37

progeny in our sample (mean family size=1.91, median=1). In summary, eight factors were extracted from the demographic survey for use in subsequent analysis: Age, BMI, Coat Colour, Gender Status, Health Status, Indoor/Outdoor Housing, Exercise, and Working Status.

2.4. Statistical model-building

Models were analyzed in Genstat 15 (VSN International, 2000-2013) using the General Linear Mixed Models option with Sire Identity as the random term. The binomial variable of Health Status was analyzed using a Binomial model with a binomial total of 2 and a Logit link function. Variables that had a normal distribution were analyzed using a Normal model with an Identity link function. Variables where the distribution of responses was right-skewed were analyzed using a Poisson model with a Logarithm link function. The single variable where the distribution was left-skewed (Fetching) was a single-question personality trait and was therefore analyzed using a Binomial model with a binomial total of 5 and a Logit link function.

For constructing the models we followed a set of rules designed to determine the explanatory variables that influenced each of the twelve response variables. The eight explanatory variables were all included in the model together. The variables with the highest p-values were then removed singly until all variables in the model had p-values $\leq$ 0.200

2.4.1. Interactions

All two-way interactions between the demographic factors were checked by including only the two independent variables and the interaction between them in the model. Only interactions which returned a p-value of 0.05 or lower during this analysis were included in the next step. These interactions were added simultaneously to the previously established model of demographic factors. Those with the highest p-values were removed until all interactions in the model had a p-value ≤ 0.05, leading to the final model.

Effect size was determined by taking the largest difference between means for a single factor in the final model, e.g. the difference between Chocolate and Black dogs for Agitated when Ignored. Average effect size is the mean of all significant effects within a factor.

3. Results

A different full model was used for each response variable. Variables included in the models and their significance are shown in Table 2; interactions present in the model are shown in Table 3, and effect sizes are shown in Table 4.

3.1. Working Status

The factor significantly associated with the most response variables was the Working Status of the dogs (Figure 2). Working Status featured in all models except Separation Anxiety, and was significantly associated with all response variables except Separation Anxiety and Owner Aggression. There was an average effect size of 0.33 over all significant associations, the highest of all factors. Pets and Gundogs were more Agitated when Ignored than Showdogs. Gundogs exhibited more Attention Seeking than Showdogs

and Pets. Pets showed greater Barking Tendency and Excitability than Gundogs. Gundogs showed higher Fetching Tendency than Showdogs or Pets, and this factor had the largest effect size (1.32). Pets and Gundogs exhibited more Human and Object Fear than Showdogs. Pets showed greater Noise Fear than Gundogs or Showdogs. Pets showed more Non-Owner Aggression than Showdogs. Gundogs exhibited greater Trainability than Pets, and both were greater than Showdogs. Finally, Showdogs and Pets were more likely to exhibit Unusual Behaviours than Gundogs.

3.2. Coat Colour

Coat Colour was also shown to be associated with several response variables, and had an average effect size of 0.19. Chocolate dogs were more Agitated when Ignored than Black dogs. Chocolate dogs showed more Excitability than Black dogs. Black dogs showed a higher Fetching Tendency than Chocolate dogs. Black and Yellow dogs showed higher Noise Fear than Chocolate. Yellow dogs showed more Separation Anxiety than Black dogs. Chocolate dogs exhibited lower Trainability and a higher incidence of Unusual Behaviour than Black or Yellow dogs.

3.3. Exercise

The amount dogs were exercised was significantly associated with several personality traits and had the third highest average effect size (0.17). Dogs exercised <1 hour/day were more likely to become Agitated when Ignored than dogs exercised 1-4 hours/day. Dogs exercised <1 hour/day had a greater Barking Tendency and greater Human and Object Fear than those exercised 4+ hours/day. Dogs exercised <1 hour/day were more

Excitable than others. Dogs exercised 1-2 hours/day were more likely to show Non-Owner Aggression than dogs exercised 2+ hours/day. Dogs exercised 1-2 hours/day were more likely to show Owner Aggression than dogs exercised 2-4 hours/day. Dogs exercised <1 or 2-4 hours/day showed more Separation Anxiety than those exercised 4+ hours/day. Dogs exercised 1+ hour/day had higher Trainability than dogs exercised <1 hour/day. Dogs exercised <1 hour/day were more likely to exhibit Unusual Behaviour than others, and dogs exercised <2 hours/day were more likely to exhibit these behaviours than dogs exercised 4+ hours/day.

3.4. Housing

Housing had an average effect size of 0.13. Dogs kept Indoor/Outdoor were more likely than Outdoor dogs to become Agitated when Ignored, although Indoor dogs were not significantly different from either group. Outdoor dogs showed less Excitability and Human and Object Fear than others, and were less likely to show Noise Fear than Indoor dogs. Dogs kept Indoor/Outdoor were more likely to show Non-Owner Aggression than other dogs.

3.5. Gender Status

Gender Status also had an average effect size of 0.13, and played a significant role in nine traits (Attention Seeking, Excitability, Human and Object Fear, Noise Fear, Non-Owner Aggression, Owner Aggression, Separation Anxiety, Trainability, and Unusual Behaviour) (Figure 3). Entire dogs showed more Attention Seeking and Excitability, and lower Human and Object Fear and Noise Fear, than Neutered Females. All Females showed

higher Non-Owner Aggression than Entire Males, and Entire Males showed higher Owner Aggression than females. Entire Males showed higher Separation Anxiety than all other categories. Entire Females had higher Trainaibility than Neutered Females. All Females showed a higher incidence of Unusual Behaviour than Entire Males.

3.6. Health, Age, BMI

Health Status had an average effect size of 0.069, the lowest of the categorical variables. Healthy dogs were more likely to exhibit Attention Seeking. Younger dogs were more likely to show Human and Object Fear. Dogs with a lower BMI were more likely to show Non-Owner Aggression.

4. Discussion

Given that the survey data by owners is subjective in nature, there is potential for inaccuracy. The large sample size of this study may counter potential imprecision in judgment. Furthermore, multiple questions targeting similar personality traits were grouped, further reducing the role of individual inaccuracies. The survey data does not allow us to directly investigate the causal relationship between variables. Therefore, these results must be discussed in terms of associations and causal relationships can only be hypothesized in most cases.

4.1. Personality trait groupings

The traits were grouped according to the PCA results and correlations. The most distinct trait group was that for Trainability which appeared separately from the others in

the PCA (Figure 1). The questions from the Aggression section were consolidated into two traits: Non-owner and Owner Aggression. Stranger, Dog, and Animal Aggression were highly correlated with each other, but not with Owner Aggression. This indicates that there are some fundamental differences between the expression of aggression towards human owners and other people and animals in the Labrador Retriever. Previous studies with the C-BARQ in a range of breeds have separated aggression into three categories, towards owners, strangers, and dogs (Hsu and Serpell, 2003; Nagasawa *et al*., 2011; Serpell and Hsu, 2005). In a study comparing aggression in a large number of breeds, Labrador Retrievers were shown to exhibit below-average levels of aggression towards owners, dogs and strangers (Duffy *et al*., 2008).

4.2. Effects of genetics and lifestyle

Genetic and experiential differences are known causes of personality variation in dogs (Podberscek and Serpell, 1996). The variation in genetics and lifestyle was primarily examined through Working Status, Coat Colour, and Exercise. Other sources of variation were accounted for in the models, including Indoor/Outdoor Housing, Health Status and BMI, but are not discussed in detail because of their limited impact in the statistical analysis.

4.2.1. Working Status

Working Status was significantly associated with 10 out of 12 personality traits and had the largest average effect sizes, making it the most influential factor. There are a number of possible explanations for these effects: genetic differences between the Working Status categories, difference in management and/or training between the categories or a

combination of the two influences. Additionally, differences in the effects of Working Status may be exaggerated by the movement of dogs from one category to another if their behaviour is inappropriate (i.e. a dog that does not perform well as a show dog becomes a pet). We will refer to this phenomenon as 'category shift'.

In terms of the genetic influence, our results may reflect a known division in this breed. Labrador Retriever breeders and dog researchers recognize two types of Labrador Retrievers, which are referred to as "conformation"-bred and "field" Labrador Retrievers in the U.S. (http://en.wikipedia.org/wiki/Labrador_Retriever, accessed 22/11/13; Duffy *et al*., 2008) or 'show' and 'working' strains in the UK (Craig, 2011). The former are generally seen in dog shows while the latter are the type generally used as gundogs in the UK. Genetic differences between the two strains may be the result of breeding animals for good 'performance' in either Showdog or Gundog roles, where performance in either category is likely to be related to the dog's behaviour and personality. Gundogs are working dogs and are expected to be responsive and obedient throughout long periods where activity (fetching/retrieval) is interspersed with periods of inactivity (waiting for the next shoot to take place), unlike Pets and Showdogs that are not relied upon to complete specific tasks. The increased Attention Seeking, Fetching, and Trainability may relate to being attentive to the commands of the handler, performing the retrieval task reliably and being easily trained for all required tasks. Similarly the decreased Barking Tendency and Noise Fear of Gundogs may be attributed to their requirement to be quiet whilst working and between shoots, and unafraid of gunshot. Gundogs were also less likely to show Unusual Behaviours, which are often labeled as 'stereotypies'. It has been shown that stereotypies are negatively associated with stimulation and engagement (Sergiel *et al.*, 2012). The lowered

tendency to exhibit Unusual Behaviour in Gundogs may be due to the increased environmental complexity that is associated with being a working dog, although category shift could also explain the observed pattern.

Showdogs have to tolerate distracting environments with many people and animals in close proximity and occasional physical handling by unfamiliar people, which may explain their lower scores for Agitated when Ignored, Human and Object Fear, Noise Fear and Non-owner aggression than Pets. The breeding of successful showdogs may have promoted these personality traits.

However, previous training and experience may also explain some of these differences in personality traits. The behavioural phenotype recorded in the questionnaire may be influenced by the training or management regime of show and working dogs. Whilst the differences in Trainability could be due to deliberate breeding strategies in Gundogs, a Gundog will also undergo intensive training for its role, often by highly experienced trainers. Therefore, the behavioural phenotype that was recorded in the questionnaire may be influenced by this training, as has been shown in other studies (Svartberg, 2002; Kutsumi et al., 2013). Similarly, Showdogs may have been become desensitized to the multiple distractions of the dog show environment, and therefore react less to these stimuli (Kubinyi *et al.,* 2009), and thus score lower in Excitability. Those that did not adapt well to either activity may have been removed due to category shift.

It is likely that both genetic and training/experience influence the personality traits documented by the questionnaire in this population of dogs. An experimental approach would be required to disentangle these factors, in which behavioural outcomes are recorded

from Show and Gundog strains that are managed and trained in pet, show and gundog environments.

4.2.2. Coat Colour

Chocolate Labrador Retrievers were different from Black and Yellow dogs for several traits. Chocolate dogs had lower Noise Fear and Trainability, and exhibited more Unusual Behaviour than yellow or black dogs. Additionally, Chocolate dogs were more Agitated when Ignored, more Excitable, and had lower Fetching than black dogs. There are two possible explanations for the differences. Firstly, the genes responsible for chocolate coat colour could be genetically linked to the genes responsible for these personality traits, which would make these characteristics likely to co-occur. The inheritance pattern of coat colour has been studied in Labrador Retrievers and other breeds, and mutations in the tyrosine related protein 1 gene (*TYRP1*) have been shown to be responsible for brown coat colour in dogs (Templeton et al., 1977; Schmutz et al., 2002), however, genetic associations between this gene and behavioural traits have yet to be investigated. Another explanation is that in the attempts of dog breeders to produce a high frequency of Chocolate dogs, the gene pool of dogs carrying the alleles for a Chocolate coat may have become somewhat separated from that of the other Labrador retrievers. By chance, traits other than coat colour may have higher frequencies in this gene pool, which could explain the differences in personality. . Although the main difference was between Chocolate dogs and other dogs, there were also some differences between Black and Yellow Labrador Retrievers (i.e. Separation Anxiety).

4.2.3. Exercise

The level of exercise and stimulation a dog gets impacts its health and mental well-being (Sergiel *et al.*, 2012). The amount of time the dogs were exercised was associated with 8 of the 12 personality traits, and it had the second highest effect sizes. Associations with personality traits could be due to the level of exercise directly influencing the expression of certain behaviours, or it could be that dogs showing unwanted traits are not taken out by owners as much as other dogs, for fear of an inability to control them leading to embarrassment or harm, which we will call 'Behavioural Deterrence'.

Dogs exercised less had higher Excitability, lower Trainability, and exhibited more Unusual Behaviour. The association between high levels of exercise and Trainability is likely in part due to an increased exposure to training during activity. Dogs exercised more showed less Unusual Behaviour, supporting the idea that higher exercise levels are good for the mental health of the dogs. The increased stimulation from human interaction and time outside in novel environments may help to reduce the incidence of stereotypies (Menor-Campos *et al.*, 2011). This however is inconsistent with the results of Clark *et al.* (1997) who found exercise had little effect on behaviour. The only behavioural difference they found was an increase in barking among dogs exercised with a conspecific. However, the periods of exercise used in their study were much shorter (20 minutes, 3 times a week) than those reported here, suggesting that the quantity of exercise is important.

Dogs exercised more showed lower Non-Owner Aggression. This could be due to increased exposure to unknown stimuli during prolonged activity. Frequent contact would help familiarize the dog to strange people, animals and environments, and reduce the likelihood of an aggressive response to novelty. This is supported by dogs exercised less also showing higher Human and Object Fear, since fear and aggression have been shown to

be correlated in other studies (Duffy *et al.*, 2008). Behavioural Deterrence may also account for these patterns, such that dogs showing non-owner aggression are not walked as often in order to avoid awkward situations for the owner.

Dogs exercised less showed higher Barking Tendency and Owner Aggression. This may again be due to Behavioural Deterrence, or they may be barking to attract the attention of owners or as an outlet for boredom. This is supported by the finding that dogs exercised less also showed more Attention Seeking and less Separation Anxiety. Boredom may lead to frustration, manifested as aggression towards the people within the household.

4.3. Gender and Age

Gender status was significant in relation to 9 out of the 12 traits. Gender status is a combination of the sex and neuter status of the dogs, and both of these may have had an effect on their personality. Gender status has previously been shown to be associated with personality traits in dogs (Wilsson and Sundgren, 1997; Svartberg, 2002), including aggressiveness and boldness. Personality differences between the groups are likely to be due to hormonal differences.

Entire Males and Entire Females differed significantly from Neutered Females for four traits. Neutered Females showed less Attention Seeking and Excitability, and showed more Human and Object Fear and Noise Fear than the Entire dogs. Neutered Males were in the middle and not significantly different from either group for all four of these traits. Excitability may be higher in Entire than Neutered Females due to differences in hormone levels.

Females showed more Non-Owner Aggression than Entire Males, and Entire Males showed more Owner Aggression and less Unusual Behaviour than all Females, and higher Separation Anxiety than all groups. Higher aggression among Males has been reported previously (Hart and Hart, 1985, Wilsson and Sundgren, 1997). Castration of male dogs has been shown to reduce aggressive dominance to some extent, but not territorial aggression (Hart and Eckstein, 1997). The latter category may contain components of the Non-owner Aggression category from the present study. However, higher Non-Owner Aggression from Females was not been reported in either of these studies. This may represent a form of territorial aggression, but levels of all aggression from this breed were low in this study.

The age of the dog is one of the easier factors to understand. The age of the animal relates to its past experience, and therefore has an influence on its personality (Stamps and Groothius, 2012). Older dogs showed significantly less Human and Object Fear. This is possibly because experience has led them to discriminate between actual threats and innocuous things. This is supported by older dogs showing less Separation Anxiety than younger dogs, although this effect was not statistically significant. Older dogs have learned their owners' routines, and are less concerned about prolonged absences.

5. Conclusions

This large-scale study of behavioural characteristics in Labrador Retrievers revealed a number of associations between physical, lifestyle and management characteristics of the dogs and personality traits. The explanatory factor with the largest overall effect was the working status of the dog, where pets showed dispositions that are generally considered less desirable than those of gundogs and showdogs. The mechanism by which working

status could affect behaviour is not yet known, but it is likely to involve both genetic and environmental factors. Further research is required to disentangle these factors. There were also significant associations between personality traits and other factors considered, including coat colour, levels of exercise, age, sex, neuter status and housing.

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583 Figure legends

584 Figure 1: Scatterplot of PC1 vs PC2 for C-BARQ responses. The different symbols refer to
585 the sections within C-BARQ (1: Training and obedience; 2: Aggression; 3: Fear and
586 anxiety; 4: Separation-related behavior; 5: Excitability; 6: Attachment and attention-
587 seeking; 7: Miscellaneous; Hsu & Serpell, 2003; http://vetapps.vet.upenn.edu/cbarq/).

588

589 Figure 2: Adjusted means for the three Working Status categories (Gundog, Pet, Showdog)
590 for the 12 personality traits described in the text (Agitated when Ignored, Attention
591 Seeking, Barking Tendency, Excitability, Fetching, Human and Object Fear, Noise Fear,
592 Non-Owner Aggression, Owner Aggression, Separation Anxiety, Trainability, and Unusual
593 Behaviour).

594

595 Figure 3: Adjusted means for the four gender/neuter status categories (EF=entire female;
596 EM=entire male; NF=neutered female; NM=neutered male) for the 12 personality traits
597 described in the text (Agitated when Ignored, Attention Seeking, Barking Tendency,
598 Excitability, Fetching, Human and Object Fear, Noise Fear, Non-Owner Aggression,
599 Owner Aggression, Separation Anxiety, Trainability, and Unusual Behaviour).

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