



## Age, sex and reproductive status affect boldness in dogs



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### ABSTRACT

Boldness in dogs is believed to be one end of the shy–bold axis, representing a super-trait. Several personality traits fall under the influence of this super-trait. Previous studies have found that boldness is affected by breed and breed groups, influences performance in sporting dogs, and is affected in some cases by the sex of the dogs. This study investigated the effects of dog age, sex and reproductive status on boldness in dogs by way of a dog personality survey circulated amongst Australian dog owners.

Age had a significant effect on boldness ( $F = 4.476$ ;  $DF = 16, 758$ ;  $P < 0.001$ ), with boldness decreasing with age in years. Males were bolder than females ( $F = 19.219$ ;  $DF = 1, 758$ ;  $P < 0.001$ ) and entire dogs were bolder than neutered dogs ( $F = 4.330$ ;  $DF = 1, 758$ ;  $P < 0.038$ ). The study indicates how behaviour may change in adult dogs as they age and adds to the literature on how sex and reproductive status may affect personality in dogs.

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### Introduction

The study of personality may offer a framework to explain some of the variation observed in animal behaviour. One of the chief benefits of understanding behavioural variability in animals is improving our ability to predict how individuals are likely to behave (Svartberg, 2003). Such information can be used to modify the way particular animals are managed and trained. In addition, it may inform decisions on the suitability of particular environments they are kept in, and the work they may be used for. Fine-tuning the way we interact with and keep animals at the individual level to best suit that individual's strengths and weaknesses has the potential to improve animal welfare and improve human–animal interactions.

Boldness in dogs has been characterised by trainability, willingness to play with humans, a low reported frequency and intensity of fearful behaviour directed towards humans and dogs, as well as non-social objects or events in previous studies (Svartberg, 2002, 2005; Svartberg and Forkman, 2002). In a second study using the methods described here, we identified one component with high positive loadings on items related to play with humans and other dogs and negative loadings on items relating to avoidance and behaviour indicating fear (Starling et al., 2013). The loadings suggest that the component we identified is similar to that labelled 'boldness' in previous studies (Svartberg, 2002; Svartberg and Forkman, 2002; Svartberg et al., 2005).

The domestic dog (*Canis lupus familiaris*) is one of the most commonly kept animals in Western societies, with 36% of households in Australia including one or more dogs (ACAC, 2010). Dogs often live in close proximity to humans, sharing living spaces in the home and public outdoor spaces for leisure activities and exercise. It is therefore of particular importance to understand our canine companions and manage and accommodate their basic nature and needs. These may change as the dog matures and ages. For example, aging dogs are known to approach cognitive tasks in different ways (Salvin et al., 2011) and may lose behavioural inhibition or the use of their senses as they age (Salvin et al., 2012). These physiological changes may have an effect on perceived personality. It is unknown when personality in dogs stabilises, but previous studies suggest behaviour in dogs under 9 months of age is not strongly indicative of adult dog behaviour in most cases (Goddard and Beilharz, 1986). There are remarkably few studies investigating whether personality in dogs may change as they age beyond early adulthood but prior to old age (Jones and Gosling, 2005).

The effect of sex and reproductive status on dog personality has been assessed in a limited number of studies. There is some evidence to suggest that neutered dogs are more aggressive, more excitable, and more anxious than entire male and female dogs (Farhody and Zink, 2010). Male neutered companion dogs are believed to be more trainable than male entire dogs (Serpell and Hsu, 2005), and male dogs have been shown to be bolder than female dogs, although this association has not been identified in high performing sport dogs (Svartberg and Forkman, 2002). In summary, the effects of sex and reproductive status on dog personality have not been widely documented or unified in a single

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study. The current study examines the effects of sex and reproductive status as well as age on aspects of personality in the dog.

## Materials and methods

### Item generation

A survey was developed for dog owners to report on the personality of their dogs. Demographic data were collected on the age and gender of the dog owners, where and when they had obtained the dog, and how long they had owned it. Survey items were drawn from the Canine Behavioural Assessment and Research Questionnaire (CBARQ) (Hsu and Serpell, 2003) and guided by previous work by Svartberg on boldness in dogs (Svartberg, 2002, 2005). CBARQ has been validated by correlating survey answers with professional diagnoses of behavioural problems (Hsu and Serpell, 2003). For the current questionnaire, items from CBARQ that may be associated with boldness or shyness and indicated by everyday dog behaviour were retained, with the exception of stranger-directed aggression. This factor has been shown to have a low loading on the component associated with boldness and was not strongly associated with aggressiveness in everyday life (Svartberg, 2005).

It is possible that aggressiveness as a trait is unrelated to the shy–bold axis (Scott and Fuller, 1965; Svartberg, 2005) or that it can be readily expressed at either end of the spectrum since aggression can emerge in bold dogs that are motivated to guard and shy dogs that are pushed to defend. Items not found to be associated with boldness and shyness were also excluded to focus on items most likely to be predictive of future behavioural tendencies. In addition, because Svartberg (2002, 2005) showed that separation-related behaviour, predatory behaviour, owner-directed aggression, and dog-directed behaviour in the home environment had no correlation with the Swedish Working Dog Club Dog Mentality Assessment (DMA) personality traits, and to that extent were not validated, these items were also excluded.

Additional items covering play behaviour developed by Svartberg (2002, 2005) were included in our questionnaire. It used two forms of five-point rating scales, with different sections using either of those forms. One was a semantic differential-type rating scale as used by Hsu and Serpell (2003) and the other offered a selection of graded options: 'never', 'seldom', 'sometimes', 'usually', and 'always', that referred to the frequency of the behaviour in the recent past.

A further section exploring proactive and reactive behaviour was added to the survey. It included questions developed from reviews of the characteristics of proactive and reactive coping styles (Koolhaas et al., 1999, 2010; Coppens and de Boer, 2010). These questions used the semantic differential-type 5-point rating scale on which respondents were asked to rate the intensity of their dog's behaviour ranging from 0, where the behaviour was not observed, to 4, where the behaviour was extreme.

### Participants

The survey was circulated via Australian Internet forums and e-mail lists with a focus on domestic dogs. Respondents were sought exclusively from Australia to avoid international variables being introduced into the results. Respondents were 18 years or over, and under 80 years in age, and were asked to report on a dog with which they lived. They were requested to complete additional surveys for additional dogs if they lived with more than one.

### Statistical analysis

Statistical analyses were carried out with the program R (R Development Core Team, 2011). Mean substitution was used for missing data as per Svartberg (2002, 2005), and surveys with more than five missing responses were not used. A principal components analysis (PCA) was run on the results from the survey. The number of components extracted was determined by the scree plot method, as there was a clear division in the scree plot.

The component extracted from the PCA was subjected to further analysis using linear mixed models using the 'lme' function in R and was used as a boldness measure. Fixed effects included dog gender, age, reproductive status, and United Kennel Club (UKC) breed group, owner gender, owner age group, and dog's origin. Breed was considered a random effect nested within the fixed effect UKC Breed Group. Terms were first tested for significance using the *t* test or 'ANOVA' function in R and, if they were significant, added to a linear model. The terms in the models were tested using the 'ANOVA' function, comparing the linear model containing the new term with a linear model excluding the new term. The Akaike Information Criterion (AIC) value was also used to assess the model-of-best-fit. The UKC breed groups included Companion, Guardian, Gundog, Scenthound, Herding, Terrier, Sighthound/Pariah, and Northern and Spitz groups. UKC breed groups are closest to the international convention adopted by Fédération Cynologique Internationale (FCI), but use fewer groups. The reduced breed groups better suited the smaller number of breeds in the current study.

The linear mixed model was then compared to the linear model containing all significant fixed-effect factors using a likelihood ratio test using the 'ANOVA' function in R to assess the significance of the random effects in the model. Dogs of mixed

breed heritage were assigned to a breed group called 'mixed' if their breed composition was unknown or only one parent was known. Where all breeds listed in the makeup of a mixed breed individual belonged to the same UKC group, the dog was categorised as also belonging to that UKC group. Otherwise the individual was categorised as 'mixed'. Dog age, sex and reproductive status were entered into the model as fixed effects.

## Results

### Principal components analysis

The survey generated 1054 responses that could be used. The PCA produced one major component (PC1) called 'boldness' that accounted for 21.4% of the variation. The retained component was characterised by high loadings on factors relating to play and sociality and negative loadings on avoidance and other behaviours indicating fear. Although this component had much in common with the over-arching personality called 'boldness' in other studies (Svartberg, 2002, 2005), it has not been validated with behavioural measures.

### Linear regression

The model-of-best-fit included five terms: age (in years), sex, reproductive status, breed, and breed group. Age and gender of the owner were not significant, and nor was origin of the dog or age of the dog when acquired. So, these terms were not included in the final model. The estimated regression coefficient and related output of the model-of-best-fit is shown in Table 1. Boldness in general decreased with age (Fig. 1) ( $F = 4.476$ , numDF = 16, denDF = 758,  $P < 0.001$ ). Age was treated as a categorical variable and is presented as such here to enable better comparison with studies where dogs are pooled into age groups (Kubinyi et al., 2009).

Male dogs were bolder than female dogs (Fig. 2a) ( $F = 19.219$ , numDF = 1, denDF = 758,  $P < 0.001$ ), and entire dogs of either sex were bolder than de-sexed dogs of either sex (Fig. 2b) ( $F = 4.330$ , numDF = 1, denDF = 758,  $P = 0.038$ ). An interaction between sex and reproductive status was tested and revealed no significant interaction. Nor were there any significant interactions between breed group and age. In most cases, there were no correlations between breed group and sex. The exception was a significant correlation between the Scenthound group and sex (male) (regression coefficient =  $-3.315$ , SE = 1.511, DF = 752,  $P = 0.029$ ), where numbers were low ( $n = 9$ ). Further analysis of breed and breed group will be discussed in a future publication.

## Discussion

The results of the current study complement those from a previous report by Kubinyi et al. (2009) that found that male dogs were bolder than female dogs and younger dogs of both sexes were bolder than older dogs. The current study showed a significant negative correlation between age of dogs and boldness: boldness scores decreased as the age of the dog increased.

Published personality and temperament studies in dogs have a strong focus on animals under 2 years of age, possibly because such studies are often aimed at improving methods of selecting individual dogs for training programs to become working dogs, for example for police, military, or guide dogs (Jones and Gosling, 2005). Conversely, there has also been some focus on aging dogs, generally  $\geq 10$  years, that may be subject to canine cognitive dysfunction (Neilson et al., 2001; Chan et al., 2002). So dogs between these age groups are poorly represented in personality studies.

In the Australian pet dogs sampled, a shift was found towards the shy end of the shy–bold axis as the dogs aged. Until the age

**Table 1**  
Statistical output of fixed effects from linear mixed model.

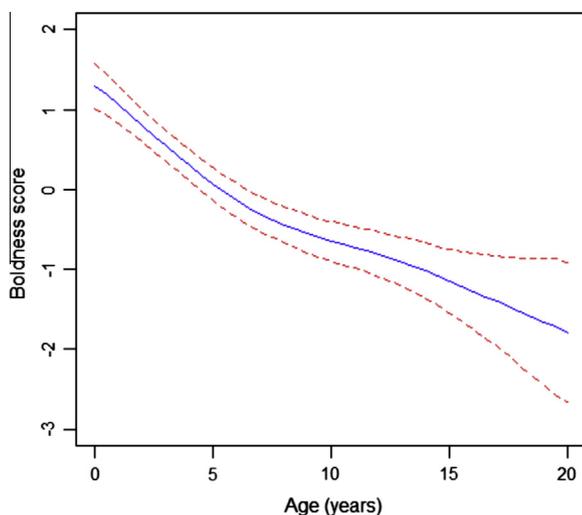
	Regression coefficient	Standard error	DF	<i>n</i>	<i>P</i>
(Companion, female, neutered, age <1 year)	-0.861	0.488	763		0.0784
Entire	0.549	0.264	763	214	<b>0.038*</b>
Male	0.768	0.198	763	505	<b>&lt;0.001***</b>
Guardian breed group	3.088	0.543	264	82	<b>&lt;0.001***</b>
Gundog breed group	1.947	0.474	264	162	<b>&lt;0.001***</b>
Herding breed group	1.575	0.445	763	228	<b>&lt;0.001***</b>
Mixed breed group	1.203	0.340	763	234	<b>0.002**</b>
Northern breed group	1.673	0.651	264	47	<b>0.012*</b>
Scenthound breed group	0.627	0.889	264	20	0.481
Sighthound breed group	1.106	0.663	264	50	0.097
Terrier breed group	1.466	0.547	763	80	<b>0.008*</b>
Age1	-0.014	0.457	763	120	0.975
Age2	-0.889	0.475	763	100	0.062
Age3	-0.510	0.474	763	108	0.282
Age4	-0.894	0.484	763	96	0.065
Age5	-1.200	0.491	763	91	<b>0.015*</b>
Age6	-2.090	0.512	763	79	<b>&lt;0.001***</b>
Age7	-1.270	0.528	763	66	<b>0.016*</b>
Age8	-1.947	0.540	763	65	<b>&lt;0.001***</b>
Age9	-1.853	0.549	763	61	<b>0.001***</b>
Age10	-1.692	0.546	763	63	<b>0.002**</b>
Age11	-2.243	0.660	763	33	<b>0.001***</b>
Age12	-1.647	0.731	763	24	<b>0.025*</b>
Age13	-0.747	0.773	763	21	0.334
Age14	-2.139	1.075	763	10	<b>0.047*</b>
Age15	-3.081	0.997	763	12	<b>0.002**</b>
Age16+	-3.822	0.996	763	12	<b>&lt;0.001***</b>

The table shows the statistical output of the fixed effects from the final linear mixed model accepted including dog sex, reproductive status, age, breed, and breed group. Significance is relative to the 'Intercept' conditions: Companion breed group, female, neutered. Age in years was considered a categorical variable rather than a continuous one to show where results deviated from a linear relationship. The statistical model used was the 'lm' and 'lme' function in the statistical package R, and models were tested using the ANOVA function in R and the AIC value. DF, degrees of freedom.

\*  $P < 0.05$ .

\*\*  $P < 0.005$ .

\*\*\*  $P < 0.001$ .



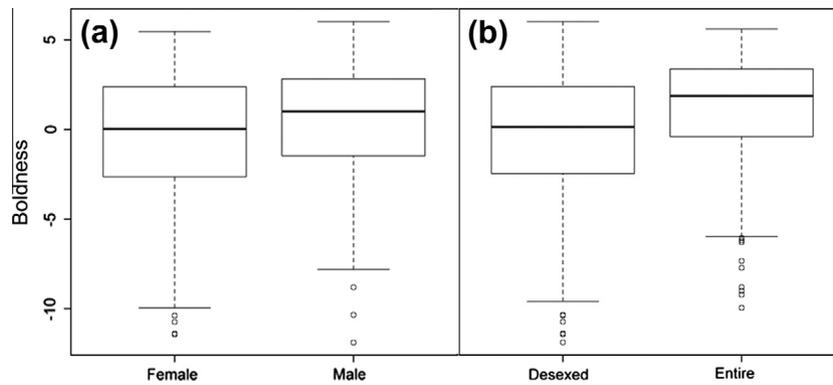
**Fig. 1.** Association between boldness and age in dogs using a spline function. Boldness decreases as age increases. The statistical model used was the 'lm' and 'lme' function in the statistical package R, and models were tested using the 'ANOVA' function in R and the AIC value.

of 13 years, a gradual shift towards shyness was observed and then the trend became much sharper after 13 years. The latter shift may be explained by age-related degenerative conditions such as osteoarthritis. Physical discomfort may lead to dogs taking fewer risks and being less inclined to interact with other dogs or people. Whilst measures of age-related cognitive decline were not collected in our study, Neilson et al. (2001) reported a reduction in

greeting and attention-seeking behaviour in dogs with this condition. Therefore, the results presented in this paper highlight the importance of undertaking further research to assess the contribution of age-related physical and cognitive degenerative conditions to the expression of a less bold personality in dogs.

The gradual decline in boldness between the age of 1 year and 13 years, while not nearly as dramatic, may be far more important. There is no published precedent to the knowledge of the authors for this significant trend. Training history and life experiences in general also play a role in dog behaviour (Goddard and Beilharz, 1986). It is possible that engaging in bold behaviour is not an overall rewarding experience for dogs in this population. For example, approaching social objects such as humans and other dogs may result in aversive experiences such as aggressive or threatening behaviour directed towards the dog approaching. Experiences such as these may result in a decrease in the frequency of behaviours positively related to boldness and an increase in frequency and intensity of the avoidance behaviours towards non-social objects negatively associated with boldness. This possibility raises questions about how dogs' interactions with social and non-social stimuli are routinely managed by dog owners (McGreevy et al., 2012), and the long-term effects this may be having on both how the dogs are likely to behave and their emotional state in their day-to-day lives.

A previous study of 264 dogs found that sociability decreased with age, but no differences in personality between sex or breed were detected (Wahlgren and Lester, 2003). Sociability towards other dogs has been shown to decrease as dogs age, but from 4 to 8 years old, sociable behaviour is affected by the time the dog spends with the owner (Kubinyi et al., 2009). Female dogs in the 4–8 years age group are more sociable towards conspecifics than male dogs in this age group (Kubinyi et al., 2009).



**Fig. 2.** (a) Boldness in male vs. female dogs. Boldness scores as extracted from the first component of a principal component analysis (PCA) is significantly greater in males than in females. The statistical model used was the 'lm' and 'lme' function in the statistical package R, and models were tested using the 'ANOVA' function in R and the AIC value. (b) Boldness in entire vs. neutered dogs of both sexes. Boldness scores as extracted from the first component of a PCA are significantly greater in entire than in neutered dogs of both sexes.

It is possible that as dogs age and accumulate ever more experiences, they naturally become less engaged in their surroundings, lose interest in exploration and show a reduction in excitement. Perhaps this is similar to a 'been there, done that' effect in human beings. This may manifest itself in more aloof or shy behaviour as they become less inclined to approach strangers or to engage in social and playful interactions. There may be such a gradual decline in interest that it is largely over-looked by owners. Chimpanzees show a decrease in 'openness', 'extraversion' and 'emotionality' with age as reported by their familiar keepers (King et al., 2005), and the same trend has been found in human beings (see, for example, McCrae et al., 1999), suggesting there may be a biological basis for a decrease in certain personality traits (Costa and McCrae, 2006) related to boldness. A slight decrease in curiosity/fearlessness, sociability and aggressiveness with age has been reported in German shepherd dogs under 5 years of age (Svartberg, 2007). This rough indication hints at the broader results reported here.

It is also possible that there is a sampling bias present. A previous study found evidence for greater energy expenditure and higher mortality in dogs scoring high in traits related to boldness (Careau et al., 2010). Bold dogs may live fast and die young, or be culled early from the population for unwanted boisterousness, leaving an increasing imbalance in the shy–bold continuum towards shyness in older age groups.

Our study has revealed that boldness in dogs is influenced by both the sex of the dog and the dog's reproductive status, and there was no interaction found between these two factors. Previous studies that examined the effects of sex on temperament revealed mixed findings.

Neutered female German shepherds have been found to be more emotionally reactive than entire females (Kim et al., 2006), and it has been found that neutered female dogs show more 'fearful' behaviour and neutered male dogs show more aggressive behaviour towards people (Meuten, 2002). These findings along with the results of the current study suggest that it is possible that neutering alters a dog's willingness to engage in social behaviours and/or their desire to avoid novel or potentially frightening non-social objects.

Male dogs of some breeds have been found to be more trainable than females of the same breed, but this effect is not uniform across all breeds (Serpell and Hsu, 2005). The same study found neutering had no effect on the trainability of female dogs of any breed, but did improve trainability in males of some breeds (Serpell and Hsu, 2005). Survey questions on trainability in the current study featured in the identification of boldness in another study (Svartberg, 2002). It was found in that study that male dogs were

bolder than female dogs, but this effect did not hold for high performance sports dogs (Svartberg, 2002).

There is some evidence that neutered dogs are more likely to be obese, although this effect may differ between breed groups and with age (McGreevy et al., 2005). Obesity may result in dogs being less inclined to move and therefore less inclined to engage in behaviours such as greeting and playing and so the dog appears to be more shy. However, avoidance behaviour directed towards non-social objects is negatively correlated with boldness in the current study. Shyness is not defined simply by a lack of behavioural response, so a lack of motivation alone is unlikely to result in a report of shyness.

Our finding that male dogs are significantly bolder than female dogs combined with findings in other studies of males being bolder (or expressing more of a trait related to boldness) under certain conditions suggests that while this study gives a broad picture of boldness between sexes in dogs, there are other factors beyond the remit of the current study that may play a role. These could include the effects of different levels of training and training for different purposes, for example.

## Conclusions

This study shows how behaviour may change in adult dogs as they age. It is recommended that this area be investigated in more detail. Understanding changes in behaviour may aid in the interpretation of a range of scientific and clinical findings related to cognition, personality, affective state, and how dogs respond behaviourally to stimuli they encounter and how the way they interact with humans and other dogs may change over time.

## Conflict of interest statement

None of the authors of this paper has a financial or personal relationship with other people or organisations that could inappropriately influence or bias the content of the paper.

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