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Behavioural reactivity of the Korean native Jindo dog varies with coat colour

Young K. Kim[a,1], Scott S. Lee[a,1], Seok I. Oh[b], Jong S. Kim[b], Euy H. Suh[c], Katherine A. Houpt[d,2], Hee C. Lee[a], Hyo J. Lee[a], Seong C. Yeon[a,*]

[a] Institute of Animal Medicine, College of Veterinary Medicine, Gyeongsang National University, Jinju 660-701, Republic of Korea
[b] Korean Jindo Dog Center, Jindo 539-823, Republic of Korea
[c] Department of Statistics, College of Natural Science, Gyeongsang National University, Jinju 660-701, Republic of Korea
[d] Animal Behaviour Clinic, College of Veterinary Medicine, Cornell University, Ithaca, NY 14853-6401, USA

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ABSTRACT

This study aimed to compare the behavioural reactivity of Jindo dogs with two different coat colours. Fawn (16 males, 15 females; mean age ± S.D. = 7.2 ± 2.1 years) and white (10 males, 10 females; mean age ± S.D. = 6.9 ± 2.1 years) Jindo dogs were exposed to a set of behavioural tests. All of the dogs were videotaped during the testing period to allow further analysis. The intensity of social, aggressive, fearful, and submissive reactivity and the frequency of urination as a scent-marking behaviour were scored on a scale running from 0 to 4 points. For each dog, each variable was defined as the average of the scores of nine behaviour tests. Then, the behavioural reactivities of Jindo dogs of each coat colour were compared. The results suggested that Jindo dogs of fawn coat colour exhibited a significantly lower intensity of fearful and submissive reactivity than those of white coat colour. In addition, fawn Jindo dogs produced scent-marking behaviour significantly more frequently. The results of the present study may provide useful information for scientific researchers, potential owners and breeders of Jindo dogs.

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1. Introduction

Animals display diverse colours and patterns that vary within and between species (Mills and Patterson, 2009). The association between coat colour and behavioural differences has been studied in various species. Higher average marking frequencies were found in black male Mongolian gerbils than in heterozygous or homozygous brown males (Turner and Carbonell, 1984). In lions, *Panthera leo*, mane darkness reflects social dominance and influences in making a wider selection of females and surviving male–male competition (West and Packer, 2002). In mountain sheep, higher rank has been shown to be associated with increasing darkness of coat, and darker rams were seen more often tending oestrous ewes (Loehr et al., 2008). In the case of dogs, a relationship exists between coat colour and aggressive behaviour in the case of English cocker spaniels, where animals with a solid coat colour show higher levels of aggression than those that are parti-coloured (Podberscek and Serpell, 1996, 1997; Pérez-Guisado et al., 2006; Amat et al., 2009).

The Jindo dog is a medium-sized Asian spitz breed, usually ranging between 35 and 45 lbs; it is indigenous to Jindo Island off the southwest end of the Korean Peninsula. The breed has been considered so valuable that they have been designated Natural Monument #53 by the South Korean government. Jindo dogs are utilized as watch dogs, hunting dogs, and companion animals on both the island and the mainland. In addition, they were officially recognized as a breed by the Federation Cynologique Internationale (FCI) and United Kennel (UK) respectively in 2005. The coat colours of the dogs that commonly occur are fawn and white (Lee et al., 2000). Anecdotally, there is believed to be a difference between the fawn and white Jindo dogs in terms of their behavioural characteristics (Lee and Kim, 1993). Also, breeders who have raised Jindo dogs for a long time, experts in the breed, and research analysts at the Jindo dog research institute believe that the Jindo dogs of fawn colour tend to show a stronger personality than those of white coat colour. This, in combination with the studies described above demonstrating links between coat colour and behaviour in other species, suggests that it is plausible that such an association may also exist in Jindo dogs. However, there have been no formal studies regarding behavioural differences between fawn and white Jindo dogs.

The purpose of the present study is to compare the intensity of behavioural reactivity of Jindo dog of two different colours, as assessed by a defined set of behavioural tests. This will allow an objective assessment of the breeders' anecdotal reports.

* Corresponding author. Tel.: +82 55 751 5825; fax: +82 55 752 7633.
E-mail address: scyeon@gnu.ac.kr (S.C. Yeon).
[1] Both authors contributed equally to this work.
[2] Current address: Animal Behavior Consultants of Northern Michigan, 3065 East Dixon Lake Road, Gaylord MI 49735.

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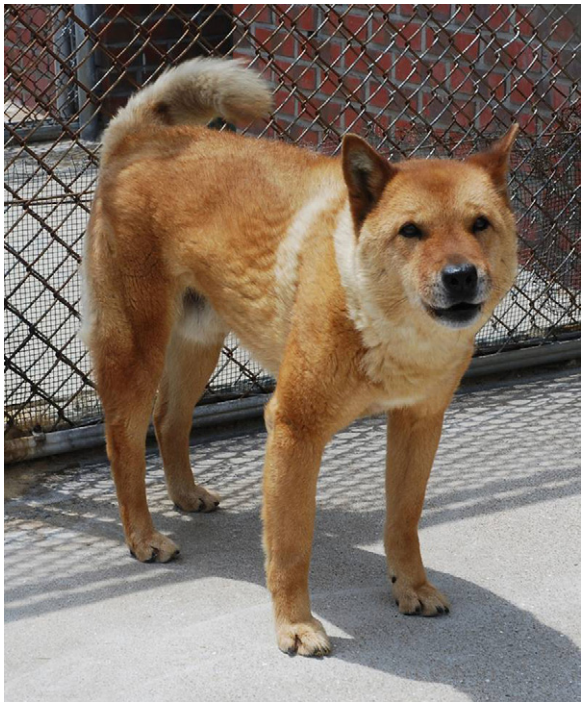

Fig. 1. A male Jindo dog with a fawn coloured coat.

2. Materials and methods

2.1. Animals

Thirty-one fawn coloured Jindo dogs (16 males, 15 females; mean age ± S.D. = 7.2 ± 2.1 years) and 20 white coloured dogs (10 males, 10 females; mean age ± S.D. = 6.9 ± 2.1 years) were subjects in the present study (Figs. 1 and 2). All of Jindo dogs included in this experiment were reared by different families and, at different ages, they were adopted to the Korean Jindo Dog Center in order to preserve their pure breed and bloodline. The dogs had been at the center for at least a year when the study began. The subjects were fed and their cages were cleaned twice a day (around 09:00 and 17:00 h) by a handler who lived and worked at the center. All dogs were housed individually in wire-mesh kennels (700 cm × 250 cm) with a small built-in enclosure (250 cm × 150 cm × 180 cm) where they would sleep. All of the Jindo dogs in the experiments were fully exposed to socialization with people since the center frequently had visitors who had contact with the dogs. Socialization with the handler also occurred through the dogs' weekly play and exercise.

Fig. 2. A male Jindo dog with a white coloured coat.

Subjects had had a veterinary examination in which no health problems were identified. Throughout the experiment, all subjects were handled according to the Laboratory Animal Control Guidelines of Gyeongsang National University, which are based on the *Guide for the Care and Use of Laboratory Animals* (Institute for Laboratory Animal Research, 1996).

2.2. Behavioural testing

In order to identify any behavioural differences between the fawn coloured and white coloured Jindo dogs, we exposed all of the subjects to a set of behavioural tests. The tests were chosen and somewhat modified from previous studies of canine temperament (Ruefenacht et al., 2002; Svartberg, 2002; King et al., 2003; Van den Berg et al., 2003; Lucidi et al., 2005; Kim et al., 2009, in press). Also, all of the behavioural tests were conducted based on previously established methods (Kim et al., 2009, in press). All of the behavioural tests were carried out in a yard visually and auditorily separated from the research institute. Six individuals were involved in the test procedures. They were the subject dog, a handler who was equally familiar to all subjects, two men (stranger I and II) who were completely unfamiliar to all subjects, a dog unknown to the subjects, and a test leader.

To ensure the consistency of the colour between different individuals' clothes, all of the experimenters put on white gowns during the test except for stranger II who wore a wide-brim hat and shielded his face with a cloth to make his appearance more strange to the subjects. The dogs were tested individually when no other dogs or people were nearby. If a dog urinated or defecated during the test, the test site was cleaned using water and then dried to provide a dry and consistent surface for subsequent tests.

The procedures for each behavioural test were standardized as much as possible. The order of testing was randomized for each subject. In order to standardize the test procedure, the test leader instructed the human participants what to do and how to act before and during each test. All of the human participants were male because, as Wells and Hepper (1999) demonstrated experimentally, a dog's reaction towards a human may be affected by that person's sex.

For the behavioural tests, the handler tethered the dog with a 1.5 m long leash to a pole at the test site. Subjects were not familiar with the test site. Then the handler stepped back to a predetermined location, out of the visual range of the dog. The test began after a 5 min habituation period to the testing site and all dogs were exposed to testing stimuli individually. For further analysis, two video cameras (DSR-PD 170, Sony, Tokyo, Japan), each of which was placed on a tripod 3 m away from the subject, one on each side were used to record all of the testing sessions. Both cameras were set up and left on prior to the beginning of testing to allow the subjects to adapt to the new setting, including the location of the camera.

The set of behavioural tests was as follows:

'Friendly approach of handler': The handler approached the subject at a normal walking speed and sat down 2 m away from the dog while speaking in a friendly manner to the dog (20 s). Then, after walking five times from left to right, within the distance of 3 m from the subject, the handler left the dog's view at a normal walking speed, calling out the dog's name as he did so.

'Friendly approach of stranger I': Stranger I approached the subject in the same manner as the handler did during the '*Friendly approach of handler*' test.

'Friendly approach of stranger II': As for '*Friendly approach of handler*', but the approach was made by stranger II.

'Threatening approach of handler': The handler held a stick (with a length of 60 cm) and approached the dog without any verbal communication. Then the handler threatened the dog by yelling and shouting (20 s) and made a striking movement with the stick while taking one step forward in the direction of the dog. The handler then walked five times from left to right, within a distance of 3 m, of the subject while staring the dog.

'Threatening approach of stranger I': As for '*Threatening approach of handler*', stranger I approached and threatened the subject.

'Threatening approach of stranger II': In the same manner as described under '*Threatening approach of handler*', stranger II approached and threatened the subject.

'Approach of a doll': The dog was confronted with a dressed doll attached to a long pole. The doll had the approximate size and appearance of a child of 2–3 years of age, and produced squeaky sound during testing. This doll was moved towards the dog and stopped just before the dog where it was left standing for 30 s.

'Opening an umbrella': Towards same direction from the same location, the test leader rapidly opened a black umbrella with an automatic opening device 2 m away from the dog regardless of the dog's position. This procedure was performed three times at intervals of 20 s.

'Approach of a strange dog with the handler': The handler approached the subject with a strange male dog on a leash, stopping at a distance of 0.5 m from the subject for 30 s. When either the strange dog or subject exhibited active aggression such as snapping or biting, the test was terminated by the test leader.

2.3. Video analysis and scoring of the behavioural reactivity

Upon completion of the experiments, the video recordings of all testing procedures were reviewed and the behavioural reactivity of all subjects toward each stimulus was rated by an observer who had no prior information about the purpose of the present study. During the analysis, the intensity of social, aggressive, fearful, and submissive reactivity was scored on a scale from 0 to 4 points (i.e. 0, no signs of reactivity; 1–3, mild to moderate signs of reactivity; and 4, severe signs of reactivity). The signs of severe reactivity of each type which meant that a score of 4 points was given are stated below. The behavioural scoring method involved in this study was modified from previous study conducted by Kim et al. (in press).

For each form of reactivity assessed, a list of behaviours was complied, each of which had to be performed for the subject to receive a 4 for the relevant form of reactivity. In case of social reactivity, a score of 4 points was assigned if a dog greeted and approached the testing stimuli immediately without hesitation, wagged its tail wide and fast, attempted to lick the stimuli, and constantly followed and oriented its eyes to the stimuli. In case of fearful reactivity, 4 points were given if a dog avoided the stimulus by performing a fast movement or lay flat and remained stationary while trembling, putting its head down, laying its ears flat against its head, and growled or barked aggressively. In case of aggressive reactivity, 4 points were given if a dog approached as close as possible to the stimuli at a high speed while attempting to bite, bark, or growl aggressively. In the case of submissive reactivity, 4 points were given if a dog either approached on its belly while wagging its tail down and lowering its head or lay on its side or back, displaying its inguinal-genital region.

Additionally, the frequency of scent-marking was scored. A score between 0 and 4 was given based on the frequency of urination in any of the following postures: stand, lean, raise, elevate, flex, squat, lean-raise, flex-raise, handstand, arch, squat-raise, and arch-raise as described in the previous study conducted by Sprague and Anisko (1973). Specifically, 0 points were given if no scent-marking behaviour was observed during each behavioural test but 1–4 points were given if any scent-marking behaviour was observed once to more than four times respectively.

Each type of behavioural reactivity and the frequency of scent-marking were scored separately for each behavioural test. If, for example, a dog first approached the stimulus while exhibiting all of the behaviours that would qualify the dog to get the social reactivity score of 4, and at times, the dog lay on its side or back with displaying its inguinal-genital region, a score of 4 was given in for social reactivity, a score of 0 for fearful reactivity, a score of 0 for aggressive reactivity, and a score of 4 for submissive reactivity and a score of 0 in the case of scent-marking.

2.4. Statistical analysis

All video samples were re-rated by the same observer to measure the intra-observer reliability of the scores of each behavioural reactivity and scent-marking. Similarities between the rated and re-rated scores were assessed using Pearson rank-order correlations (PRCC). Additionally, the samples of the videos, randomly selected, were rated by two additional observers to measure the inter-observer reliability of the scores and Cronbach's alpha was calculated.

For each dog, each variable was defined as the average of the scores of nine behaviour tests. Then the behavioural reactivity of fawn dogs was compared to that of white dogs. Given that dogs' behaviour could be influenced by its sex (Takeuchi and Mori, 2006; Notari and Goodwin, 2007), for each of the four types of behavioural reactivity assessed, and the frequency of scent-marking, a 2×2 ANOVA with the factors coat colour and sex was used. $P < 0.05$ was considered to be statistically significant.

All statistical tests were performed by use of statistical software SPSS 14.0 (SPSS Inc., Chicago, USA).

3. Results

3.1. Reliability of measures

Intra-observer reliability of social (PRCC = 0.937, $P < 0.001$), aggressive (PRCC = 0.925, $P < 0.001$), fearful (PRCC = 0.907, $P < 0.001$), submissive (PRCC = 0.924, $P < 0.001$) reactivity, and scent-marking (PRCC = 0.964, $P < 0.001$) was high. Also, the inter-observer reliability between three observers was high. Specifically, the Cronbach's alpha for the social, fearful, aggressive, submissive reactivity, and scent-marking were 0.85, 0.82, 0.87, 0.74 and 0.94 respectively. In summary, observer reliability was sufficiently high for all measures.

3.2. Differences of behavioural scores based on the coat colour and sex

Based on the statistical results (Table 1), sex had a significant effect on fearful, and submissive reactivity and on scent-marking. Male dogs were significantly lower than were female dogs in fearful reactivity (mean ± S.D. for males: 1.67 ± 0.43, for females: 2.27 ± 0.55) and submissive reactivity (mean ± S.D. for males: 1.69 ± 0.443, for females: 2.10 ± 0.41). In addition, male dogs displayed scent-marking behaviour significantly more frequently than did female dogs (mean ± S.D. for males: 0.23 ± 0.22, for females: 0.13 ± 0.10).

After considering the effects of the sex, fearful, submissive reactivity and scent-marking differed significantly by coat colour. The fawn dogs were significantly lower than the white dogs in fearful reactivity (mean ± S.D. for fawn coat colour: 1.77 ± 0.65, for white coat colour: 2.02 ± 0.28) and submissive reactivity (mean ± S.D. for fawn coat colour: 1.72 ± 0.53, for white coat colour: 1.96 ± 0.35).

Table 1
The statistical results of the 2 × 2 ANOVA with the factors coat colour and sex for each type of behavioural reactivity, and for scent-marking.

Source	Social reactivity		Aggressive reactivity		Fearful reactivity[†]		Submissive reactivity[†]		Scent-marking[a]	
	F	*P*-value	*F*	*P*-value	*F*	*P*-value	*F*	*P*-value	*F*	*P*-value
Coat colour	0.001	0.982	0.198	0.660	8.111	0.008	4.282	0.048	6.195	0.019
Sex	0.548	0.465	0.004	0.948	20.027	0.000	10.243	0.003	4.534	0.042
Coat colour × sex	0.221	0.642	0.093	0.763	3.660	0.066	0.369	0.549	0.015	0.905

[a] Coat colour and sex of Jindo dogs had significant effects on fearful and submissive reactivity, and on scent-marking. $P < 0.05$.

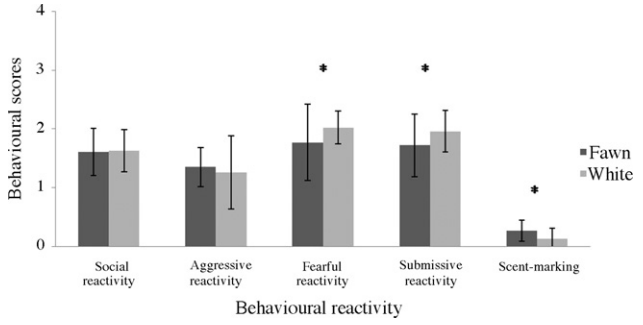

Fig. 3. Comparisons of the mean score (±S.D.) for each type of behavioural reactivity measured, and for scent-marking, for fawn and white Jindo dogs. *There are significant differences between the fawn and white coat colours. ANOVA: $^*P < 0.05$.

In addition, the fawn dogs were significantly higher than the white dogs in scent-marking frequency (mean ± S.D. for fawn coat colour: 0.27 ± 0.18, for white coat colour: 0.13 ± 0.18) (Fig. 3).

Among the 12 elimination postures described by Sprague and Anisko (1973), 2 postures, stand and handstand, were not observed in the Jindo dogs; the other 10 postures were observed.

4. Discussion

A limited amount of research has been done by objective observations of the behaviour of Jindo dogs and most of the behavioural evaluation on the breed tends to be very subjective. Based on the testimonies of breeders who have raised dogs of this breed for a long time, and on evaluations of the breed over many generations, the Jindo dogs of both coat colours are thought to possess different temperament (Lee and Kim, 1993). Also, the Jindo dogs of fawn coat colour are believed to possess stronger temperaments than those of white coat colour. These beliefs have an initial credibility because they are held by people who have had opportunities to observe Jindo dogs' behavioural responses in a range of practical, real world situations over a long time. These observations have not been subjected to direct, objective, scientific assessment, however. Thus, in our study, we selected behavioural tests that resembled realistic situations that the subjects could be expected to encounter in their daily lives. These tests allowed an objective assessment of the reports of breeders which had only been subjective previously, and, indicated that Jindo dogs of fawn coat colour exhibited significantly lower intensity in terms of fearful and submissive reactivity than those of white coat colour. Based on the results, we suggest that the subjective belief commonly held by people who have observed Jindo dogs for a long time that fawn dogs have stronger personalities may have developed because fawn Jindo dogs typically exhibit lower intensity fearful and submissive reactivity.

It is well known that the sex of a dog influences its behaviour. As such, although our primary focus was on the effects of coat colour on behaviour, this study also took the effects of subjects' sex into an account. This analysis indicated that, in comparison to female Jindo dogs, males exhibited significantly lower fearful and submissive reactivity toward testing stimuli. Therefore, dogs' sex seems to be a factor that influences the behaviour of Jindo dogs in addition to coat colour. Similar to our results, a previous study conducted by Döring et al. (2009) using various breeds of dog, reported that male dogs exhibited fewer fearful responses than did female dogs when tested at a veterinary practice.

Coat colour is highly polymorphic in dogs. Coat colour depends on skin and hair pigment synthesis and several genes, *MC1R* (melanocortin 1 receptor), *TYRP1* (tyrosinase related protein 1), *ASIP* (agouti signal peptide) and *K* (beta-defensin 103), are believed to be involved in determining the coat colour of dogs (Schmutz et al., 2002; Hédan et al., 2006; Schmutz and Berryere, 2007). Ortolani (1999) suggested that, there are three primary reasons that animals' colour patterns might change through evolution: camouflage, communication, and physico-physiological functions. Colour patterns are associated with specific environment variables in the carnivore. Moreover, behaviour is an essential factor playing a role in the evolution, and probably maintenance, of carnivore colour patterns. Somewhere along the evolutionary timeline over which Jindo dogs became domesticated, variant coat colours, namely fawn (which is the most prevalent), and white developed, and behaviour may have played a role in this evolutionary process.

Quantitative, experimental investigations of the relationships between coat colour and behaviour have been carried out since the 1940s with studies on laboratory rats, ranch mink and foxes. Several mechanisms have been suggested to explain observed connections between coat colour and temperament traits (Keeler, 1942; Hemmer, 1990; Amat et al., 2009). One such possible mechanism is that that melanin which is key to pigmentation has a similar biochemical synthesis pathway to dopamine and other neurotransmitters, which contribute to the control of behaviour. It is possible that genetic differences underlie both coat colours through such a mechanism and behavioural differences in Jindo dogs; however these genes remain to be identified. The current study did identify behaviours that differ according to coat colour, however.

In this study, no significant differences based on the coat colour could be observed in terms of aggressive reactivity. This is not consistent with the previous studies which used different behavioural evaluation methods from the present study and found differences in the level of aggression within the same breed of English cocker spaniels depending on different coat colours (Podberscek and Serpell, 1996, 1997; Pérez-Guisado et al., 2006; Amat et al., 2009). There are many potential causes of aggressive behaviours in dogs, among which those that trigger aggressive behaviour for territorial defence seem to be the most prominent. In this study, both groups showed strong aggressive reactivity toward an approaching strange male dog, and towards an unknown human approaching in a threatening manner during behavioural tests. However, we believe that the Jindo dogs exhibited less aggressive reactivity than they otherwise would have because the present study was conducted in a place to which the subjects were unaccustomed. Therefore, in the near future, comparative studies of aggressive behaviours, including dominant, territorial, fear-induced, predatory, and inter-dog aggression under different conditions should be undertaken.

According to the current results, in comparison to white Jindo dogs, fawn dogs showed significantly more frequent scent-marking. Sprague and Anisko (1973) observed 12 elimination postures in dogs. Of these, lean, raise, elevate, flex, squat, lean-raise, flex-raise, arch, squat-raise, and arch-raise were observed in the current study. Also, we observed subjects scratching the ground using their forelimbs, as well as their hindlimbs following urination. Scent-marking by urination is a common practice in the family *Canidae* and, according to previous studies, males show much more frequent scent-marking behaviours (Bekoff, 1979; Pal, 2003). Consistent with these previous studies, the current study found that the sex of Jindo dogs had a significant effect on the frequency of scent-marking, specifically, such behaviour was more frequently observed in males. While urination clearly functions to achieve elimination for both sexes, it is thought to play a smaller role in scent-marking in female dogs than in male dogs (Bekoff, 1979; Wirant and McGuire, 2004). However, according to Wirant and McGuire (2004), urination in female dogs does not function solely as a mean of elimination, but it also has an important function in scent-marking, even when females are not in oestrus.

Through this study, we were able to identify differences in the frequencies of scent-marking behaviours between the fawn and white Jindo dogs. However, solely based on our data, it might be difficult to determine what contribution coat colour alone made to differences in scent-marking behaviours because, as Wirant et al. (2007) suggested, in case of female dogs, frequencies of scent-marking behaviour could have changed depending on the stage of the oestrous cycle. By the time we identified a difference in frequency of marking behaviour between the two groups of Jindo dogs, it was too late to keep track of what stage of their oestrous cycle female dogs were in while they were being tested. In order to better understand differences in scent-marking behaviour related to coat colour, further studies which consider the effects of various factors including subjects' reproductive status, age, and the location in which testing occurs should be performed.

Since all dogs included in the present study were reared for breeding and preservation, there were no dogs that had specific training. However, it is still possible that environmental factors may have contributed to the behavioural differences observed between fawn and white dogs currently observed, in addition to the possible genetic factors discussed above. The dogs in the present study were raised under different conditions by different families during their critical period for socialization. Given the widely held beliefs about temperament differences between fawn and white Jindo dogs in Korea, these families may have treated fawn dogs differently to white dogs. If such different treatment did occur, then it may have contributed to the differences in behaviour that we observed. Therefore, based on the results of the present study, a further study which involves detailed analysis of the environmental contributions to Jindo dog behaviour may help to identify the causes of the observed behavioural differences between dogs of the two coat colours.

In conclusion, although there has previously been information about the behavioural traits associated with the two coat colours of Jindo dogs, most of it has been based on anecdotal evidence. This report is the first objective study to investigate the behavioural differences between Jindo dogs of different coat colours. Based on this study, the differences between fawn and white Jindo dogs were identified as levels of fearful and submissive reactivity and frequency of scent-marking. The results of the present study may provide useful information for scientific researchers, and for potential owners and breeders of Jindo dogs. Lastly, based on the results associated about the behaviours of dogs of each coat colour, a scientific analysis of the genes involved in these behaviours should be performed to explain the mechanism through which these behavioural differences are linked to coat colour differences.

References

Amat, M., Manteca, X., Mariotti, V.M., Ruiz de la Torre, J.L., Fatjó, J., 2009. Aggressive behavior in the English cocker spaniel. J. Vet. Behav. 4, 111–117.

Bekoff, M., 1979. Scent-marking by free-ranging domestic dogs—olfactory and visual components. Biol. Behav. 4, 123–139.

Döring, D., Roscher, A., Scheipl, F., Küchenhoff, H., Erhard, M.H., 2009. Fear-related behaviour of dogs in veterinary practice. Vet. J. 182, 38–43.

Hédan, B., Corre, S., Hitte, C., Dréano, S., Vilboux, T., Derrien, T., Denis, B., Galibert, F., Galibert, M.D., André, C., 2006. Coat colour in dogs: identification of the Merle locus in the Australian shepherd breed. BMC Vet. Res. 2, 1–10.

Hemmer, H., 1990. Domestication: The Decline of Environmental Appreciation. Cambridge University Press, Cambridge, 121 pp.

Institute for Laboratory Animal Research, 1996. Guide for the care and use of laboratory animals. National Academy Press, Washington, DC.

Keeler, C.E., 1942. The association of the black (non-agouti) gene with behavior in the Norway rat. J. Hered. 33, 371–384.

Kim, Y.K., Lee, S.S., Oh, S.I., Lee, G.W., Kim, J.S., Chang, H.H., Suh, E.H., Lee, H.C., Lee, H.J., Yeon, S.C., 2009. Jindo dog's ethogram revealed by behavioral test. J. Vet. Clin. 26, 238–245.

Kim, Y.K., Lee, S.S., Oh, S.I., Kim, J.S., Suh, E.H., Houpt, K.A., Lee, H.C., Lee, H.J., Yeon, S.C., in press. Behavioral reactivity of Jindo dogs socialized at an early age compared with non-socialized dogs. J. Vet. Med. Sci.

King, T., Hemsworth, P.H., Coleman, G.J., 2003. Fear of novel and startling stimuli in domestic dogs. Appl. Anim. Behav. Sci. 82, 45–64.

Lee, C.G., Kim, G.T., 1993. The coat color of Jindo dogs. Korean J. Vet. Res. 33, 763–772.

Lee, C.G., Lee, J.I., Lee, C.Y., Sun, S.S., 2000. A review of the Jindo, Korean native dog—review. Asian-Australas. J. Anim. Sci. 13, 381–389.

Loehr, J., Carey, J., Ylönen, H., Suhonen, J., 2008. Coat darkness is associated with social dominance and mating behaviour in a mountain sheep hybrid lineage. Anim. Behav. 76, 1545–1553.

Lucidi, P., Bernabò, N., Panunzi, M., Villa, P.D., Mattioli, M., 2005. Ethotest: a new model to identify (shelter) dogs' skills as service animals or adoptable pets. Appl. Anim. Behav. Sci. 95, 103–122.

Mills, M.G., Patterson, L.B., 2009. Not just black and white: pigment pattern development and evolution in vertebrates. Semin. Cell Dev. Biol. 20, 72–81.

Notari, L., Goodwin, D., 2007. A survey of behavioural characteristics of pure-bred dogs in Italy. Appl. Anim. Behav. Sci. 103, 118–130.

Ortolani, A., 1999. Spots, stripes, tail tips and dark eyes: predicting the function of carnivore colour patterns using the comparative method. Biol. J. Linn. Soc. 67, 433–476.

Pal, S.K., 2003. Urine marking by free-ranging dogs (*Canis familiaris*) in relation to sex, season, place and posture. Appl. Anim. Behav. Sci. 80, 45–59.

Péerez-Guisado, J., Lopez-Rodríguez, R., Muñoz-Serrano, A., 2006. Heritability of dominant–aggressive behaviour in English Cocker Spaniels. Appl. Anim. Behav. Sci. 100, 219–227.

Podberscek, A.L., Serpell, J.A., 1997. Environmental influences on the expression of aggressive behaviour in English Cocker Spaniels. Appl. Anim. Behav. Sci. 52, 215–227.

Podberscek, A.L., Serpell, J.A., 1996. The English Cocker Spaniel: preliminary findings on aggressive behaviour. Appl. Anim. Behav. Sci. 47, 75–89.

Ruefenacht, S., Gebhardt-Henrich, S., Miyake, T., Gaillard, C., 2002. A behaviour test on German Shepherd dogs: heritability of seven different traits. Appl. Anim. Behav. Sci. 79, 113–132.

Schmutz, S.M., Berryere, T.G., 2007. Genes affecting coat colour and pattern in domestic dogs: a review. Anim. Genet. 38, 539–549.

Schmutz, S.M., Berryere, T.G., Goldfinch, A.D., 2002. TYRP1 and MC1R genotypes and their effects on coat color in dogs. Mamm. Genome 13, 380–387.

Sprague, R.H., Anisko, J.J., 1973. Elimination patterns in the laboratory beagle. Behaviour 47, 257–267.

Svartberg, K., 2002. Shyness–boldness predicts performance in working dogs. Appl. Anim. Behav. Sci. 79, 157–174.

Takeuchi, Y., Mori, Y., 2006. A comparison of the behavioral profiles of purebred dogs in Japan to profiles of those in the United States and the United Kingdom. J. Vet. Med. Sci. 68, 789–796.

Turner Jr., J.W., Carbonell, C., 1984. A relationship between frequency of display of territorial marking behavior and coat color in male Mongolian gerbils. Lab. Anim. Sci. 34, 488–490.

Van den Berg, L., Schilder, M.B.H., Knol, B.W., 2003. Behavior genetics of canine aggression: behavioral phenotyping of Golden Retrievers by means of an aggression test. Behav. Genet. 33, 469–483.

Wells, D.L., Hepper, P.G., 1999. Male and female dogs respond differently to men and women. Appl. Anim. Behav. Sci. 61, 341–349.

West, P.M., Packer, C., 2002. Sexual selection, temperature, and the lion's mane. Science 297, 1339–1343.

Wirant, S.C., Halvorsen, K.T., McGuire, B., 2007. Preliminary observations on the urinary behaviour of female Jack Russell Terriers in relation to stage of the oestrous cycle, location, and age. Appl. Anim. Behav. Sci. 106, 161–166.

Wirant, S.C., McGuire, B., 2004. Urinary behavior of female domestic dogs (*Canis familiaris*): influence of reproductive status, location, and age. Appl. Anim. Behav. Sci. 85, 335–348.