

## ARTICLES

# Effects of breed, sex, and neuter status on trainability in dogs

James A. Serpell\* and Yuying Hsu†

\* School of Veterinary Medicine, University of Pennsylvania, USA

† Department of Life Science, National Taiwan Normal University, Taipei, Taiwan

### Abstract

*In a previous study of canine temperament (Hsu and Serpell 2003), a distinct “trainability” factor was identified, characterized by a dog’s willingness to attend to its owner and obey simple commands, combined with a high “fetch” motivation, and low levels of distractibility and/or resistance to correction. This paper explores the distribution of this trait in a large sample of dogs in relation to breed, sex and neuter status. The owners of 1,563 dogs belonging to 11 common breeds were invited to assess them for “trainability” using a standardized questionnaire (C-BARQ®). Highly significant breed differences in trainability were detected. In two breeds with distinct field and show bred lines, show bred dogs obtained significantly lower trainability scores. Although no overall sex differences in trainability were detected, male Dachshunds and West Highland White Terriers were found to be significantly more trainable than females. Neutering was not associated with any differences in trainability in female dogs in any breed, but was associated with positive effects on trainability in male Shetland sheepdogs. The findings suggest that there is scope for improving trainability in most breeds of dog, and emphasize the dangers of generalizing among breeds with respect to sex differences in trainability or the benefits of neutering. The biological basis of the trainability trait is also discussed in light of recent research on the evolution of canine social cognition.*

**Keywords:** breed differences, dog, social cognition, temperament, training

Although consistent breed differences in behavior and temperament are generally acknowledged in popular literature on dogs, there have been surprisingly few quantitative studies of the nature and extent of these differences. In their pioneering work on canine behavioral genetics, Scott

---

**Address for correspondence:** Prof. James Serpell, School of Veterinary Medicine, University of Pennsylvania, Philadelphia, PA 19104-6010, USA. Ph: 215-898-1004; fax: 215-573-6050; e-mail: serpell@vet.upenn.edu.

and Fuller (1965) investigated the genetic basis for temperament differences among five breeds: Basenjis, Cocker Spaniels, Beagles, Shetland Sheepdogs and Wire-haired Fox Terriers, using a battery of behavioral tests. Analysis of variance in test scores by individual, litter and breed revealed strong and statistically significant effects of breed on the expression of many of the traits measured. Inter-breed differences on both test scores and overall working performance have also been noted in quantitative comparisons of some hunting and livestock guarding breeds (Coppinger et al. 1988; Willis 1995; Brenøe et al. 2002). Consistent breed-specific behavioral profiles have also been found in surveys that invited knowledgeable “experts,” such as dog handlers and veterinarians, to rank breeds according to their behavior in specific situations (Hart and Hart 1985; Hart 1995).

One explanation for the paucity of research on breed differences in behavior is the scarcity of valid, reliable, and standardized methods for measuring behavioral phenotypes in the canine population. Temperament and performance tests tend to be relatively laborious to conduct, and in most cases their reliability and validity are uncertain (e.g., Scott and Fuller 1965). In comparison, evaluations derived from surveys save considerable time and effort but suffer from similar reliability and validity issues (Hart 1995). To overcome some of these problems, the present study made use of a recently developed survey instrument—the Canine Behavioral Assessment and Research Questionnaire (C-BARQ<sup>®</sup>)—that accesses quantitative information on the behavior of individual dogs from their owners or from other persons familiar with the dog’s typical responses to common environmental events and stimuli. The C-BARQ has been shown previously to have adequate reliability and validity characteristics (Hsu and Serpell 2003).

C-BARQ assessments provide quantitative scores for several distinct behavioral traits or factors. Only one of these factors—trainability—is addressed in the present paper. Although not always well defined, “trainability,” or the ability and motivation to attend and respond in a positive way to human cues or signals, is clearly a crucial aspect of successful task performance in the majority of working dogs. Information on dogs relinquished to animal shelters by their owners also suggests that aspects of trainability, such as obedience to commands, are important in maintaining healthy relations between companion dogs and their owners (Salman et al. 2000). Establishing the reasons why some individuals and breeds of dog are more or less trainable than others therefore has implications both for the utility value of dogs as working and/or social partners, and for their welfare.

Depending on how “trainability” is defined, the issue of breed differences is also interesting from an evolutionary perspective. It has often been

observed anecdotally that wolves, even when tamed, are relatively difficult to train compared with dogs (Crisler 1958; Fentress 1967; Woolpy and Ginsburg 1967; Frank 1980; Frank and Frank 1982; Coppinger and Coppinger 2001). Recent experimental studies have confirmed that domestic dogs exhibit heightened sensitivity and responsiveness to human social cues and communication signals, and that they perform consistently better than either hand-reared wolves or chimpanzees on human-guided tasks (Agnetta, Hare and Tomasello 2000; Hare et al. 2002; Call et al. 2003; Cooper et al. 2003; Miklósi et al. 2003; Hare et al. 2005). Such findings suggest that this trait is a product of human selection under domestication. Understanding inter- and intra-breed variation in trainability may therefore help to shed further light on the evolutionary mechanisms that gave rise to the dog's specialized social cognitive skills.

## **Methods**

### **Data Collection and Survey Methods**

Behavioral data on trainability were collected from dog owners using the Canine Behavioral Assessment and Research Questionnaire (C-BARQ<sup>®</sup>). The C-BARQ is a standardized survey instrument designed to measure various aspects of behavior and temperament in dogs. The current version consists of 101 questions that address the ways in which dogs typically respond to common events and stimuli in their natural environment.<sup>1</sup> Sixty-eight of these items were originally condensed by factor analysis into 11 distinct factors that together accounted for 57% of the common variance in questionnaire item scores (Table 1). With the exception of "touch sensitivity," all of these factors were found to be reliable (i.e. internally consistent, Cronbach's alpha > 0.7), and the first seven were found to be valid in the sense that they discriminated effectively between dogs independently diagnosed as either displaying or not displaying corresponding behavior problems (Hsu and Serpell 2003). The construct validity of the remaining four factors, including trainability, could not be assessed by this method.

The trainability factor used in the present study consisted of eight questionnaire items scored from 0–4, with factor loadings in the range of 0.55–0.77, and a Cronbach's alpha coefficient of 0.8 (Table 2). These items encompassed various aspects of trainability: e.g., a dog's willingness to attend to the owner, obey simple commands, fetch objects, respond positively to correction, learn quickly, and ignore distracting stimuli. Each individual dog's trainability score was calculated as the average of the eight item scores. Previous analyses demonstrated that there is little cross-loading between trainability and any other C-BARQ factor (Hsu and Serpell 2003).

**Table 1.** Descriptions of main C-BARQ factors.

<b>C-BARQ Factors</b>	<b>Description</b>	<b>Cronbach's Alpha</b>
Stranger-directed aggression (10 items)	Responds threateningly or aggressively to strangers approaching or invading the dog's or owner's personal space, territory, or home range.	0.93
Owner-directed aggression (8 items)	Responds threateningly or aggressively to the owner or other members of household when challenged, manhandled, stared at, stepped over, or when approached while in possession of food or objects.	0.84
Stranger-directed fear (4 items)	Responds fearfully or warily when approached directly by strangers.	0.91
Nonsocial fear (6 items)	Reacts fearfully or warily to sudden or loud noises, traffic, and unfamiliar objects and situations.	0.74
Dog-directed fear/aggression (5 items)	Responds fearfully and/or aggressively when approached directly by unfamiliar dogs.	0.81
Separation-related behavior (8 items)	Vocalizes and/or engages in destructive behavior when separated from the owner, often accompanied or preceded by behavioral and autonomic signs of anxiety including restlessness, loss of appetite, trembling, and excessive salivation.	0.80
Attachment or attention-seeking (8 items)	Maintains close proximity to the owner or other members of household, solicits affection or attention, and becomes agitated when the owner gives attention to third parties.	0.74
Trainability (8 items)	Shows willingness to attend to the owner, obeys simple commands, fetches objects, responds positively to correction, learns quickly, and ignores distracting stimuli.	0.80
Chasing (4 items)	Pursues cats, birds, and other small animals given the opportunity.	0.83
Excitability (6 items)	Reacts strongly to potentially exciting or arousing events, such as going for walks or car trips, doorbells, arrival of visitors, and the owner arriving home.	0.80
Touch sensitivity (3 items)	Reacts fearfully or warily to potentially painful procedures, including bathing, grooming, claw-clipping, and veterinary examinations.	0.67

**Table 2.** Trainability items as presented in the C-BARQ (item factor loadings shown in parentheses). Items 1–4 and 8 are scored as Never = 0, Always = 4; items 5–7 are scored as Never = 4, Always = 0. Total trainability factor score is calculated as the average of the individual item scores.

	Never	Seldom	Some- times	Usually	Always	
1. When off the leash, returns immediately when called.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	(0.67)
2. Obeys the “sit” command immediately.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	(0.73)
3. Obeys the “stay” command immediately.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	(0.77)
4. Seems to attend/listen closely to everything you say or do.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	(0.55)
5. Slow to respond to correction or punishment; “thick-skinned.”	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	(-0.59)
6. Slow to learn new tricks or tasks.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	(-0.61)
7. Easily distracted by interesting sights, sounds or smells.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	(-0.59)
8. Will “fetch” or attempt to fetch sticks, balls, or objects.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	(0.61)

## Participants

Study participants consisted of members of 11 AKC-recognized national breed clubs. Most of these clubs were chosen due to the relative popularity of their breeds, a desire to include a diversity of breed types, and willingness on the part of the clubs to participate in the survey and either distribute questionnaires to their members, or provide access to their membership lists.

C-BARQ questionnaires were distributed to breed club members by ordinary mail, together with an explanatory letter and pre-paid return envelope. To “randomize” the samples, most C-BARQ recipients were selected from either the first or last 300 members listed alphabetically in each club’s membership directory. The Labrador Retriever club elected to distribute the C-BARQ to its own members, and sent questionnaires to the first 488 mem-

**Table 3.** Sample characteristics (breeds listed in ascending order of trainability based on C-BARQ scores)

Breed	<i>n</i>	% Female	% Neutered	Age in years (mean ± SD)	C-BARQ trainability score (mean ± SD)
1. Labrador Retriever	291	53.6	26.1	5.74 ± 2.89	3.24 ± 0.39
2. Golden Retriever	179	46.4	50.0	5.29 ± 2.83	3.14 ± 0.55
3. Shetland Sheepdog	117	47.9	47.9	7.42 ± 3.83	3.12 ± 0.50
4. Rottweiler	94	46.4	40.4	6.00 ± 2.92	3.09 ± 0.46
5. English Springer Spaniel	254	51.6	28.4	5.04 ± 2.44	3.06 ± 0.50
6. Poodle	71	60.6	33.8	6.87 ± 3.43	3.05 ± 0.57
7. Yorkshire Terrier	93	59.1	44.6	6.15 ± 3.41	2.76 ± 0.64
8. West Highland White Terrier	93	61.3	46.1	6.66 ± 3.64	2.59 ± 0.64
9. Dachshund	122	48.4	45.1	6.67 ± 3.60	2.46 ± 0.68
10. Siberian Husky	96	42.6	41.7	7.19 ± 4.13	2.17 ± 0.66
11. Basset Hound	153	53.3	51.3	5.74 ± 3.29	2.06 ± 0.65
ALL BREEDS	1563	51.8	39.2	6.00 ± 3.27	2.90 ± 0.66

bers listed alphabetically in its directory. The English Springer Spaniel Field Trial Association also chose to distribute the C-BARQ itself and in a somewhat different fashion: 187 (100%) members with field (working) bred Spaniels were sent questionnaires, and the Trinity College online random number generator (<http://random.org/>) was used as the basis for sampling 300 out of a total of 367 members with conformation (show) bred Spaniels.

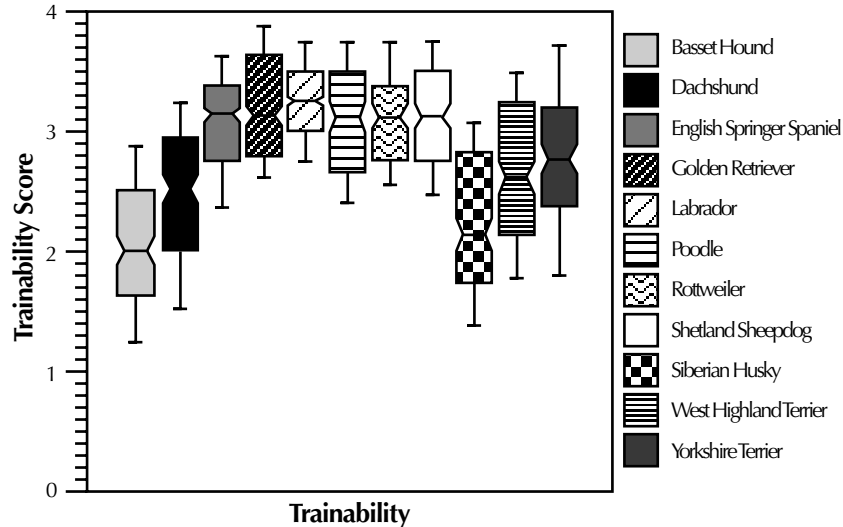
In addition to the C-BARQ assessments, information was also collected on each dog's age, sex and neuter status. For Labradors and English Springer Spaniels only, owners were also asked to state whether the dog was field or conformation (show) bred, if known.

To ensure statistical independence, each respondent was asked to assess only one dog—preferably one that was well known—that was at least one year old at the time of assessment. Respondents with more than one dog were asked to write all of their names on scraps of paper, put them in a suitable container, and draw one at random for evaluation.

## Analyses

Data were analyzed using StatView 5.1 software (SAS Systems) and non-parametric tests: Chi-square tests for comparing nominal variables, and

**Figure 1.** Box plots of trainability in eleven breeds of dog (showing medians, and 10th, 25th, 75th and 90th percentiles).



Mann-Whitney and Kruskal-Wallis tests for between-group comparisons of ordinal C-BARQ data.

## Results

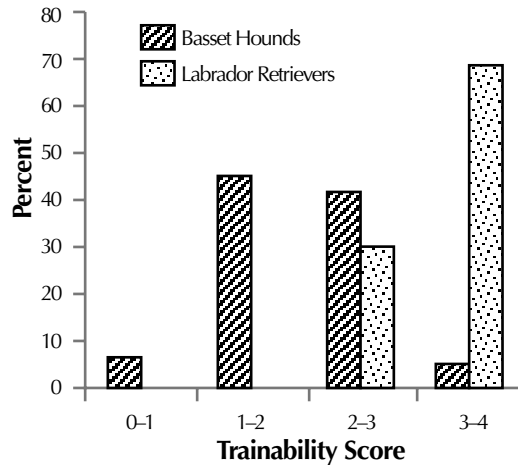
### Descriptive Statistics

A total sample of 1,563 owners completed useable C-BARQ returns. Return rates ranged from 35% (Poodle) to 58% (Labrador Retriever), with an average of 49%. The main descriptive characteristics of the sample, including breed-specific C-BARQ scores, are provided in Table 3. Breeds did not differ significantly from each other in terms of sex ratio, although there were marked breed differences in the ratio of intact to neutered dogs ( $\chi^2 = 60.3$ ,  $p < 0.0001$ ). Post hoc cell contributions suggested that Labradors and English Springer Spaniels were statistically over-represented in the intact group while Basset Hounds and Golden Retrievers were under-represented.

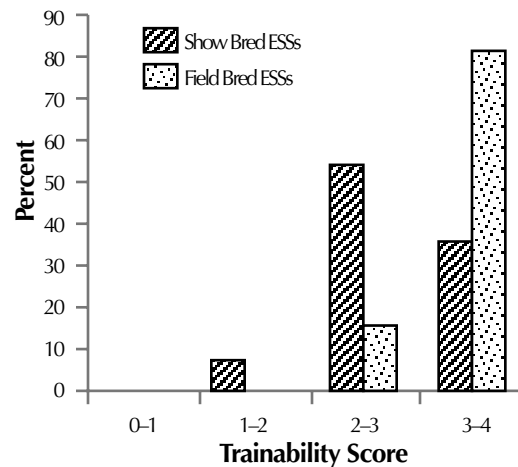
### Breed Differences in Trainability

As shown in Figure 1, the eleven breeds investigated in this study differed significantly from each other in trainability (Kruskal-Wallis  $H = 377.342$ ,  $p < 0.0001$ ). In general, high scoring breeds were less variable for this trait than low scoring breeds, and the distribution of their scores showed evidence of a “ceiling effect”—i.e., scores skewed toward the upper ranges. This effect is readily seen in Figure 2, in which the frequency distribution of scores for the highest (Labrador Retriever) and lowest (Basset Hound) scoring breeds are compared.

**Figure 2.** Frequency distribution (percentages) of “trainability” scores for Basset Hounds and Labrador Retrievers, the lowest and highest ranking breeds, respectively.



**Figure 3.** Frequency distribution (percentages) of C-BARQ “trainability” scores in field and conformation (show) bred English Springer Spaniels.



For the two breeds—Labradors and English Springer Spaniels—for which this information was available, field bred (working) dogs typically obtained significantly higher (better) trainability scores than conformation (show) bred dogs (Mann-Whitney  $U = 4706.0, p < 0.01$  and  $U = 2429.0, p < 0.0001$ , respectively). As illustrated in Figure 3, this effect was most marked in the English Springer Spaniel.

Indeed, although the English Springer Spaniel breed ranked fifth overall in terms of trainability, field bred English Springer Spaniels obtained a higher mean score ( $3.38 \pm 0.31$ ) than the Labrador, the highest ranking breed in this study.

### Influence of Sex and Neutering on Trainability

When C-BARQ scores for either the entire sample, or just neutered or sexually intact dogs were analyzed, no statistically significant sex differences in trainability could be detected. However, some breed-specific sex differences were noted. Male Dachshunds and West Highland White Terriers were found to be significantly more trainable than females (M-W  $U = 713.0, p < 0.05$ , and  $U = 255.0, p = 0.037$ , respectively). This effect persisted in the terrier when only sexually intact animals were included in the analysis ( $U = 48.5, p = 0.039$ ), but disappeared in the Dachshund.

Neutering was associated with significantly higher trainability scores in two breeds: the Shetland Sheepdog (M-W  $U = 625.0, p < 0.001$ ) and the Rottweiler ( $U = 702.5, p = 0.029$ ). When male and female dogs were considered separately, neutering was not associated with any significant effects on female trainability in any breed (although group sizes were sometimes too small to render these results reliable, e.g., female Poodles,  $n = 10$ ), but was associated with significantly higher trainability scores in male Shetland Sheepdogs ( $U = 160.5, p = 0.0035$ ).

## Discussion

Among the eleven breeds surveyed, the study detected highly significant interbreed differences in trainability, as measured by the C-BARQ instrument. If it is assumed that systematic, breed-specific biases in owner reporting are unlikely, these phenotypic differences presumably reflect either underlying genetic differences and/or the effects of non-shared environmental factors such as differences in socialization and formal training during ontogeny. For two breeds—the Labrador Retriever and the English Springer Spaniel—the study also detected line differences in trainability between field bred and show bred strains, with the latter obtaining significantly poorer scores. The fact that this effect was most marked in the Spaniel points to a genetic basis for this difference, since the field and show bred lines in this breed in the USA have been genetically isolated from each other for much longer ( $\pm 70$  years) than is the case with the Labrador.<sup>2</sup> This exaggerated within-breed effect in the Spaniel compared with the Labrador would be more difficult to explain in terms of environmental factors such as differential training or socialization. Overall, such findings tend to support the claims of some authorities that selective breeding of dogs for conformation traits—as opposed to working performance—may have deleterious effects on their behavior (e.g., Coppinger and Coppinger 2001).

The relative rankings of breeds on trainability in the present study were somewhat similar to those obtained for the factor “obedience training” in the study by Hart and Hart (1985) based on a survey of “experts.” In the latter survey, which used a system of decile ranks to compare breeds, the Basset Hound was also one of the lowest ranking breeds, the West Highland White Terrier, Yorkshire Terrier and Dachshund tended to be ranked toward the lower end of the range, and the Labrador, Golden Retriever, Poodle and Shetland Sheepdog were among the highest ranking breeds. Although the two studies are not strictly comparable due to different approaches and measurement techniques, they do provide some evidence of cross-validation.

The overall lack of statistically significant sex differences in trainability found in this study was unexpected, given the widespread belief that female

dogs are generally easier to train than males (Hart and Hart 1985). This may reflect a mismatch between the present study's definition of "trainability" and the colloquial definition, or the possibility that the breeds assessed in this study happen to be relatively sexually monomorphic for this trait.

The limited effects of neutering on trainability need to be interpreted with caution, given that some owners may have elected to neuter their dogs in order to improve their trainability, despite the lack of empirical evidence for a benefit of neutering in this regard (Hart and Hart 1985). The positive effects of neutering observed in the present study were breed-specific and more pronounced in male dogs. Breeders and owners of dogs in which a high degree of trainability is desired should therefore be wary of assuming that neutering will invariably enhance this trait. The possible neuroendocrine and genetic basis for such breed differences would probably repay more detailed study.

From an evolutionary standpoint, the distribution of breeds with respect to the C-BARQ trainability factor supports the view that at least some of the existing variation in this trait is related to human selection for enhanced social cognitive skills in certain breeds. The Labrador stands out in this respect, but all of the six high-scoring breeds (English Springer Spaniel, Golden Retriever, Labrador, Poodle, Rottweiler and Shetland Sheepdog) tend to be somewhat clustered (see Figure 1), and all of them originate from working lines associated with the performance of specialized cooperative tasks such as sport hunting/retrieving (English Springer Spaniel, Golden Retriever, Labrador, Poodle) or herding/protection (Rottweiler and Shetland Sheepdog). Such complex tasks require dogs that are exceptionally responsive to verbal and non-verbal signals and cues provided by their human partners. In contrast, the three middle-scoring breeds (Dachshund, West Highland White Terrier and Yorkshire Terrier) are small, moderately independent dogs that were developed originally for the tenacious pursuit of small prey species underground where human cues and signals were largely redundant. The lowest scoring breed, the Basset, is a scent hound that traditionally hunted in packs with little human guidance. Indeed, the short legs of the Basset Hound enable humans to follow them on foot without losing track of them altogether in the heat of the chase. The low score of the Siberian Husky concurs with the observation that huskies, as a breed, tend to exhibit relatively "wolfish" behavior (Bradshaw and Nott 1995), and the fact that this breed appears to be more "primitive" or wolf-like genetically than the other breeds included in this study (Parker et al. 2004).

These results suggest that existing breeds of dog exhibit variable social cognitive skills depending on the working roles they were originally selected to fulfill. These findings contrast with the results of Pongracz et al. (in press) who found no statistically significant breed differences in the ability

of dogs to derive cues from human demonstrators in experimental trials. It is possible that this discrepancy reflects the difference between “trainability” as measured by C-BARQ and the ability to follow human guidance cues in experimental trials. It may also be the case that the present study included a greater diversity of breed types and was therefore more likely to detect breed differences in this trait.

The present findings do not necessarily suggest that human selection for trainability contributed to the observed social cognitive difference between domestic dogs and wolves (Hare et al. 2002; Call et al. 2003; Miklósi et al. 2003). Indeed, recent work on captive foxes (*Vulpes sp.*), implies that this difference between dogs and wolves may be an unexpected by-product of early selection for tameness (Hare et al. 2005). The results do, however, indicate that subsequent selection for more specialized and interactive working skills may have accentuated this ability in some breeds compared with others. They also suggest that where selection has been relaxed, as in some show bred lines, deterioration in the expression of these skills may be quite rapid.

## Acknowledgements

The authors thank Kathy Kruger for assisting with the distribution of questionnaires, and all the breed clubs and their members who participated in the survey.

## Notes

1. Copies of the C-BARQ are available from the author on request.
2. For further information on the differences between field and show bred English Springer Spaniels see: <http://www.essft.com/fieldshow.html>.

## References

- Agnetta, B., Hare, B. and Tomasello, M. 2000. Cues to food location that domestic dogs (*Canis familiaris*) of different ages do and do not use. *Animal Cognition* 3: 107–112.
- Bradshaw, J. W. S. and Nott, H. M. R. 1995. Social and communication behaviour of companion dogs. In *The Domestic Dog: Its Evolution, Behaviour and Interactions with People*, 115–130, ed. J. A. Serpell. Cambridge: Cambridge University Press.
- Brenøe, U. T., Larsgard, A. G., Johannessen, K-R. and Uldal, S. H. 2002. Estimates of genetic parameters for hunting performance traits in three breeds of gun hunting dogs in Norway. *Applied Animal Behaviour Science* 77: 209–215.
- Call, J., Brauer, J., Kaminski, J. and Tomasello, M. 2003. Domestic dogs (*Canis familiaris*) are sensitive to the attentional states of humans. *Journal of Comparative Psychology* 117: 257–263.
- Cooper, J. J., Ashton, C., Bishop, S., West, R., Mills, D. S. and Young, R. J. 2003. Clever hounds: social cognition in the domestic dog (*Canis familiaris*). *Applied Animal Behaviour Science* 81: 229–244.

- Coppinger, R. and Coppinger, L. 2001. *Dogs: A Startling New Understanding of Canine Origin, Behavior & Evolution*. New York, NY: Scribner.
- Coppinger, R., Coppinger, L., Langeloh, G., Gettler, L. and Lorenz, J. 1988. A decade of use of livestock guarding dogs. In *Proceedings of the Vertebrate Pest Conference*, Vol. 13, 209–214, ed. A. C. Crabb and R. E. Marsh. Davis, CA: University of California.
- Crisler, L. 1958. *Arctic Wild*. New York, NY: Harper & Bros.
- Fentress, J. 1967. Observations on the behavioral development of a hand-reared male timber wolf. *American Zoologist* 7: 339–351.
- Frank, H. 1980. Evolution of canine information processing under conditions of natural and artificial selection. *Zeitschrift für Tierpsychologie* 53: 389–399.
- Frank, H. and Frank, M. G. 1982. On the effects of domestication on canine social development and behavior. *Applied Animal Ethology* 8: 507–525.
- Hare, B., Brown, M., Williamson, C. and Tomasello, M. 2002. The domestication of social cognition in dogs. *Science* 298: 1634–1636.
- Hare, B., Plyusnina, I., Ignacio, N., Schepina, O., Stepika, A., Wrangham, R. and Trut, L. 2005. Social cognitive evolution in captive foxes is a correlated by-product of experimental domestication. *Current Biology* 15: 226–230.
- Hart, B. L. 1995. Analyzing breed and gender differences in behaviour. In *The Domestic Dog: Its Evolution, Behaviour and Interactions with People*, 65–77, ed. J. A. Serpell. Cambridge: Cambridge University Press.
- Hart, B. L. and Hart, L. A. 1985. *Canine and Feline Behavioral Therapy*. Philadelphia: Lea & Febiger.
- Hsu, Y. and Serpell, J. A. 2003. Development and validation of a questionnaire for measuring behavior and temperament traits in pet dogs. *Journal of the American Veterinary Medical Association* 223: 1293–1300.
- Miklósi, A., Kubinyi, E., Topál, J., Gácsi, M., Virányi, Z. and Csányi, V. 2003. A simple reason for a big difference: Wolves do not look back at humans, but dogs do. *Current Biology* 13: 763–766.
- Parker, H. G., Kim, L. V., Sutter, N. B., Carlson, S., Lorentzen, T. D., Malek, T. B., Johnson, G. S., DeFrance, H. B., Ostrander, E. A. and Kruglyak, L. 2004. Genetic structure of the purebred domestic dog. *Science* 304: 1160–1164.
- Pongrácz, P., Miklósi, A., Vida, V. and Csányi, V. In press. The pet dog's ability for learning from a human demonstrator in a detour task is independent from breed and age. *Applied Animal Behaviour Science*.
- Salman, M. D., Hutchison J., Ruch-Gallie, R., Kogan, L., New, J. C., Kass, P. H. and Scarlett, J. M. 2000. Behavioral reasons for relinquishment of dogs and cats to 12 shelters. *Journal of Applied Animal Welfare Science* 3: 93–106.
- Scott, J. P. and Fuller, J. L. 1965. *Genetics and the Social Behavior of the Dog*. Chicago, IL: Chicago University Press.
- Willis, M. B. 1995. Genetic aspects of dog behaviour with particular reference to working ability. In *The Domestic Dog: Its Evolution, Behaviour and Interactions with People*, 51–64, ed. J. A. Serpell, Cambridge: Cambridge University Press.
- Woolpy, J. H. and Ginsburg, B. E. 1967. Wolf socialization: a study of temperament in a wild social species. *American Zoologist* 7: 357–364.