## SCIENTIFIC STUDIES

Attached are three scientific studies conducted by Dr. Franklin McMillan in regard to the mental and behavioral health of breeding dogs in commercial breeding facilities and puppies sold from these establishments.

Below is Dr. McMillan's testimony to be heard on April 20, providing a summation.

My name is Dr. Frank McMillan and my address is 5142 Golfside Dr, Lebanon, Ohio.

I'm a veterinarian who began my career in private practice, then became a clinical professor of medicine at the Western University College of Veterinary Medicine.

Following that I became a researcher at Best Friends Animal Society studying psychological trauma in animals, publishing dozens of scientific papers and writing the textbook *Mental Health and Well-being in Animals*, now in its 2nd edition.

In collaboration with the University of Pennsylvania, we conducted two large-scale studies of dogs from high volume commercial breeding establishments – the adult breeding dogs as well as the puppies sold through pet stores.

The evidence from these studies showed that these breeding facilities are highly injurious to both groups of dogs, resulting in severe, extensive, and long-term harm to the dogs' psychological and behavioral well-being.

The adult breeding dogs showed high levels of fears and phobias, compulsive and repetitive behaviors such as spinning in tight circles and pacing, as well as many other unusual and abnormal behaviors.

Our results suggested that the mental harm occurs in modern, clean, and hygienic facilities as well as those poorly maintained.

We concluded that current state and federal laws are inadequate to protect dogs from the psychological harm resulting from confinement in commercial breeding establishments.

To close I'll note that the reason dogs suffer psychological damage in these breeding facilities is not a mystery. During domestication dogs were selectively bred over the last 15,000 years to be not just social animals, but *companion* animals – which has created heightened psychological and emotional needs for social companionship. Quite simply, unlike many farm animal species, dogs are not, and never have been, production animals.

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# Mental health of dogs formerly used as 'breeding stock' in commercial breeding establishments

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ABSTRACT

Canine commercial breeding establishments (CBEs) are kennel facilities where puppies are produced in large numbers for commercial sale. In the popular media, CBEs are commonly referred to as "puppy mills" or "puppy farms." Conditions in CBEs vary widely in quality. Dogs in these facilities are routinely housed for their entire reproductive lives in cages or runs, and provided with minimal to no positive human interaction or other forms of environmental enrichment. Numerous anecdotal reports have suggested that after removal from CBEs many of the former breeding dogs display persistent behavioural and psychological abnormalities when compared with the general pet dog population. The purpose of this study was to determine if this anecdotal evidence could be confirmed empirically.

Behavioural evaluations of the dogs were obtained from current owners/fosterers using the Canine Behavioural Assessment and Research Questionnaire (C-BARQ), which utilizes ordinal scales to rate either the intensity or frequency of the dog's behaviours. A total of 1169 former CBE dogs were included in the study.

Among the CBE ex-breeding dogs, 76 different breeds were represented. With the exception of the Bichon Frise (31.5%), all other breeds comprised <5% of the dogs. The sex ratio was 70.3% females and 29.7% males. The dogs had been living in their adoptive homes for an average of 2 years when the C-BARQ was completed.

When compared with a convenience sample of pet dogs matched for breed, sex, age and neuter status, former CBE breeding dogs were reported as showing significantly higher rates of health problems (23.5% versus 16.6%, $P=0.026$). With respect to behaviour, CBE dogs displayed significantly higher rates of fear (both social and nonsocial; ordinal GLM models, $P<0.001$), house-soiling ($P<0.001$), and compulsive staring ($P<0.005$); and significantly lower rates of aggression (toward strangers and other dogs; $P<0.0001$), trainability ($P<0.0001$), chasing small animals ($P<0.0001$), excitability ($P<0.0001$), and energy ($P<0.0001$).

By demonstrating that dogs maintained in these environments develop extreme and persistent fears and phobias, possible learning deficits as evidenced by lower trainability, and often show difficulty in coping successfully with normal existence, this study provides the first quantitative evidence that the conditions prevailing in CBEs are injurious to the mental health and welfare of dogs.



## 1. Introduction

The commercial dog breeding industry is a major producer of purebred dogs in many countries around the world. The owners of these facilities refer to themselves

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by different names, such as 'professional breeding kennels,' 'high-volume breeders,' and 'large-scale breeders.' In some countries (e.g., the UK and Australia) these breeding establishments are referred to as 'puppy farms.' In the USA, the mass production aspect of these operations at some point gave rise to the term 'puppy mill,' which has come to be defined by many as 'a commercial farming operation in which purebred dogs are raised in large numbers' (Merriam-Webster, 2010). For the purposes of this report, high-volume puppy producing operations will be referred to as commercial breeding establishment (CBE).

In general, CBEs are operated like other production animal enterprises, and the dogs are viewed and treated as livestock (Hinds, 1993). Conditions in CBEs vary from modern, clean, and well kept to squalid, noxious, and grave and potentially detrimental to animal health and welfare (Hinds, 1993; Smalley, 2009; USDA, 2004). Common to virtually all CBEs are the following: large numbers of dogs; maximally efficient use of space by housing dogs in or near the minimum space permitted by law; housing breeding dogs for their entire reproductive lives—in most cases, years—in their cages or runs; dogs rarely if ever permitted out of their primary enclosures for exercise or play; absence of toys or other forms of enrichment; minimal to no positive human interaction or companionship; and minimal to no health care (Bradley, 2010; Fischer, 2010; Shaughness and Slawecki, 2010).

Numerous anecdotal reports suggest that dogs formerly maintained as breeding dogs in CBEs display behavioural and psychological abnormalities when compared with the general pet dog population (Bradley, 2010; Lockwood, 1995). If true, a number of factors may contribute to the development of such abnormalities, the prime candidates being severe and/or chronic stress (e.g., restrictive confinement, under- or overstimulation, social conflict, social deprivation, physical factors), inadequate socialization, genetics, and maternal adversity. The goal of the present study was to determine if the anecdotal evidence of behavioural and psychological abnormalities in dogs from CBEs could be confirmed by comparing owner-derived behavioural assessments of former CBE breeding dogs with those of typical pet dogs. Identification of any differences that adversely affect the dogs' welfare would indicate the need for, and guide the development of, preventive, corrective, and therapeutic measures.

## 2. Materials and methods

### 2.1. Data collection

Behavioural evaluations of the dogs were obtained from current owners/fosterers using the Canine Behavioural Assessment and Research Questionnaire (C-BARQ; http://www. cbarq.org) (Hsu and Serpell, 2003). The C-BARQ is designed to provide quantitative assessments of a wide array of behavioural characteristics of dogs, and has been widely used as a research tool for comparing behaviour in different dog populations (Duffy et al., 2008; Otto et al., 2004; Serpell and Hsu, 2005; Van den Berg et al., 2010). The questionnaire consists of 101 items which ask respondents to indicate using a series of 5-point ordinal rating scales their dogs' typical responses to a variety of everyday situations during the recent past. The scales rate either the intensity (aggression, fear and excitability subscales) or frequency (all remaining subscales and miscellaneous items) of the behaviours, with a score of 0 indicating the absence of the behaviour and a score of 4 indicating the most intense or frequent form of the behaviour. The C-BARQ currently comprises 14 behavioural factors or subscales (calculated as the mean of the questions pertaining to each subscale), and a further 22 miscellaneous stand-alone items. Higher scores are generally less favorable for all items and subscales with the exception of trainability, for which higher scores are more desirable. In addition, the C-BARQ asks dog owners if their dog is "currently experiencing any significant health problems" (yes/no) and if they are "currently experiencing any problems with this dog's behaviour or temperament", to which they can select from among the following: no problems, only minor problems, moderate problems, serious problems. Owners were also asked to indicate the dog's current age at the time the survey was completed, the dog's age when it was acquired, and whether or not there are any other dogs living in the same household. The C-BARQ automatically records the time and date when the survey is submitted and this information, together with the aforementioned data, allowed calculation of the duration of time that the dog had been living in the home at the time of survey completion. Four sections in the C-BARQ include 'open field comments' that permit the participant to elaborate on their dog's behaviour relative to the behavioural category of the question (e.g., situations where the dog is sometimes aggressive, is fearful or anxious, becomes over-excited, and other stereotyped or repetitive behaviours).

### 2.2. CBE ex-breeding dog sample

Dogs were recruited for the study in one of four ways: (1) direct solicitation of adopters and fosterers of dogs previously confiscated from CBEs by an animal protection organization[1] and subsequently offered for adoption; (2) solicitation via a notice placed in the same organization's magazine; (3) all national and local animal welfare organizations listed in the Best Friends Animal Society databank as involved with 'puppy mill rescue' were contacted and asked to distribute the solicitation notice to the people with whom they had placed former breeding dogs (foster care or full adoption); and (4) a solicitation notice posted on a dog website (dogforums.com). Further distribution via word of mouth was not discouraged. No geographical restrictions were imposed. The solicitation notice for the study contained both an email address and telephone number. Individuals responding via email were provided with a link to the online questionnaire; telephone respondents were also provided with the link or, if they lacked internet access, were mailed a hardcopy of the questionnaire together with a postage-paid return envelope. The owners were made aware of the purpose of the study in the form of a single

[1] Best Friends Animal Society.

sentence included in the solicitation notices. The magazine and website notice stated that we were looking for dogs for a study of "psychological effects of living in a commercial breeding facility ("puppy mill")"; the email notice sent via rescue groups announced, "a large scale study on dogs that were once used as breeding dogs in commercial breeding facilities ('puppy mills')," with the stated purpose: "we are trying to fully understand the psychological changes that occur in the dogs that have experienced this kind of life."

The dogs included in the study were those that had been used, or confined with the intention to be used, as breeding dogs in CBEs. The stipulation that the dog had been used for breeding purposes in a CBE/puppy mill was for the purpose of distinguishing adult dogs from puppies that were transported out for sale before 12 weeks of age. In reality, it is not possible in every case to confirm that a dog recovered from a CBE had been used for breeding. The study, however, was not intended to evaluate the effects of breeding *per se*, but rather the confinement in a CBE. The criteria used for inclusion in the study were based on the fact that, except for rare exceptions, dogs are not kept in these facilities if they are unable to successfully reproduce. Therefore, if the dog is confined in a CBE and over 1 year of age, it is a near certainty it is being used, or is intended for use, as a breeding dog. Any dog less than 8 months of age at the time of removal from the CBE was excluded from the study, and any dog over 1 year was included. Dogs between 8 and 12 months of age were included only if confirmed to be a breeding dog (or intended breeding dog) by a CBE operator. To avoid reliance on memory and hence recall bias, only dogs currently living and in that person's care were included in the study.

To assure that each dog in the study had no known history of psychological trauma outside of their CBE experience, one question was added to the survey asking the owner to select from a list of traumatic events and/or write in any known sources of trauma their dog had experienced. Only those dogs whose owners selected the answer "was rescued from a puppy mill where he/she was being used as a breeding dog" were included in the study.

In the solicitation of participants the term 'puppy mill' was used for two reasons. First, while the term 'puppy mill' is considered by some to be derogatory and judgmental, the definitions of puppy mill and CBE may be considered synonymous. For example, Merriam-Webster (2010) defines 'puppy mill' as "a commercial farming operation in which purebred dogs are raised in large numbers"; this also accurately describes a canine commercial breeding establishment. Based on personal communication with the groups involved in the recovery and rescue of these dogs it is clear that the adopters and fosterers were familiar with the term 'puppy mill' and unfamiliar with the term 'commercial breeding establishment.' Second, the groups involved with rehoming these dogs have 'puppy mill' in their name and/or use the term to describe large commercial breeding establishments when conducting any activities or communications related to the dogs they assist.

### 2.3. Pet dog sample

For the purposes of comparison, a convenience sample of C-BARQ assessments of pet dogs was used. Beginning in April 2006, free access to the online version of the C-BARQ became available to pet owners. The survey was advertised via an article in the newsmagazine of the Veterinary Hospital of the University of Pennsylvania (Kruger, 2006) and by notices sent to Philadelphia-area veterinary clinics and the top 20 US breed clubs based on AKC registrations. Availability of the survey then spread via word of mouth. Breed designations are based entirely upon owner assertions. From a dataset containing 13,620 pet dogs, a subset of dogs was randomly chosen to serve as matched controls for the CBE breeding dogs. Cases were matched on the basis of age (±6 months), sex, breed and (when possible) neuter status.

For comparison of former CBE breeding dogs with a control set of pet dogs, the analysis was limited to dogs that had been in the home for at least 3 months in order to allow sufficient time for owners to become familiar with their dogs' typical behavioural responses. An additional 36 CBE breeding dogs were removed from analysis because their neuter status was not reported by their owners. This left us with 715 dogs in the age-verified CBE ex-breeding dog dataset for which we attempted to find a matching control case with respect to approximate age (±6 months), sex, breed and (when possible) neuter status within the pet owner dataset. We were able to find age-, sex-, and breed-matched controls for 332 of the CBE ex-breeding dogs, yielding a total sample size of 664 dogs (332 CBE ex-breeding dogs and 332 matched controls). As reported by their owners, the control cases had been acquired from a variety of sources ('bred by owner': 9 (2.7%), 'breeder': 181 (54.5%), 'pet store': 22 (6.6%), 'friend or relative': 33 (9.9%), 'stray': 8 (2.4%), 'shelter': 62 (18.7%), and 'other': 17 (5.1%)).

### 2.4. Statistical analyses

All statistical analyses were performed using SPSS version 17 software. Chi-square tests were used to compare categorical variables between the two samples (CBE ex-breeding dogs and pet dogs). A Kruskal–Wallis test was used to compare the duration of ownership between the two samples. Ordinal Generalized Linear Models (GLM) were fitted to assess the effect of the dog's background (CBE ex-breeding dogs versus matched controls) on each C-BARQ item/subscale, with the presence of other dogs in the home (other dogs; yes/no), the length of time in the home (duration of ownership in months), and neuter status included as potential confounding effects. Corrections for multiple tests were performed using a Sequential Bonferroni procedure (Holm, 1979) in which $P_i \leq \text{alpha}/(1+k-i)$ where alpha = 0.05, $k = 36$ and $P_i = P_1, P_2, P_3, \ldots, P_{36}$.

## 3. Results

### 3.1. CBE ex-breeding dog data

A total of 1420 completed surveys were received, of which 251 were eliminated because: (1) the dog was not a

former CBE breeding dog, (2) the dog's CBE breeding history could not be ascertained from the owner, and (3) the questionnaires were incomplete or contained duplicate entries. This left a final sample size of 1169 for the descriptive analysis of CBE dogs. Due to some initial errors in the owners' reporting of the age of the dogs when evaluated and when acquired (e.g., some cases where the age at which the dog was evaluated was younger than when it was reportedly acquired), owners of all former CBE breeding dogs were contacted in order to verify the age of the dog and the approximate date on which it was obtained. Of these, 851 responded with the information necessary to perform analyses involving the dogs' ages and length of time living in the home.

Among the CBE ex-breeding dogs, 76 different breeds were represented. The largest represented breed was the Bichon Frise (31.5%); Papillon, Shih Tzu, and Golden Retriever each comprised just under 5% of the dogs (4.96%, 4.96%, 4.88%, respectively). Other breeds comprised 4% or less of the population. The most likely explanation for the high proportion of Bichon Frises in our study is that the director of a very large Bichon breed rescue organization (Small Paws Rescue, Tulsa, Oklahoma) was extremely diligent in obtaining the participation of the adopters of their former CBE dogs. The sex ratio was 70.3% females and 29.7% males, consistent with the greater proportion of breeding females than males in CBEs. Most of the dogs were living in multi-dog households (91.4%).

Health problems affected approximately one-quarter (26.8%) of CBE ex-breeding dogs, while behavioural concerns were reported in over 80% of the dogs, with 47.9% reporting only minor behavioural problems, and 33.2% reporting moderate to serious problems. Based on the subset of former CBE breeding dogs for whom the age when acquired and evaluated could be verified ($N = 851$), dogs were acquired at the age of 5 years on average (±0.09 SE; minimum and maximum age acquired: 0.83 years and 15 years, respectively) and had been living in their adoptive homes for an average of 24 months (±10.08 SE; minimum and maximum time in the home: <1 month and 202 months, respectively) when the C-BARQ was completed. On average, dogs were 7 years old (±0.12 SE) at the time of data collection (minimum and maximum ages: 1 year and 25 years old, respectively). It should be borne in mind, however, that estimates of CBE dogs' ages are, in many cases, a matter of educated guesswork based on standard aging criteria, such as dental disease and body condition (Hinds, 1993; USDA, 2004).

### 3.2. Comparison of former CBE breeding dogs with 'typical' pet dogs

Fifty different breeds were represented in the data; 17.5% of the samples were Bichon Frise and 12% were Golden Retrievers. Chihuahuas, Shih Tzus, and Papillons comprised 6.9%, 5.7%, and 4.8% of the data, respectively. The remaining breeds each comprised ≤4% of the data, all of which were included in the analysis. The combined sample consisted of 65.7% females and 34.3% males.

Health and behavioural concerns were reported at significantly higher rates among owners of former CBE breeding dogs than for matched controls, with 23.5% of CBE ex-breeding dog owners reporting health problems compared to 16.6% of matched pet owners ($\chi^2 = 4.974$, df = 1, $P = 0.026$), and 83.1% reporting behavioural concerns compared to 56.0% of pet owners ($\chi^2 = 57.63$, df = 1, $P < 0.0001$) (see Table 1). A significantly greater proportion of former CBE ex-breeding dogs lived in multi-dog households compared to the matched controls (88.6% compared to 67.8%, respectively; Chi-square test, $\chi^2 = 42.0$, df = 1, $P < 0.0001$). The duration of time for which the dogs had been living in the home prior to evaluation was significantly lower among former CBE ex-breeding dogs than the matched controls (Kruskal–Wallis test: $\chi^2 = 240.6$, df = 1, $P < 0.0001$; mean number of months = 20.6 ± 1.07 SE for former CBE ex-breeding dogs versus 57.5 ± 1.92 SE for matched controls).

We compared the C-BARQ scores of former CBE breeding dogs to matched controls using separate multinomial ordinal GLMs (with cumulative logit link function) with the C-BARQ item/subscale as the response variable for each model. For the response variables, the 22 stand-alone items were used in their original raw format (i.e., the ordinal scale of 0 through 4). Due to their non-normal and often highly skewed, semi-discrete distributions, the 14 subscales were converted into ordinal variables using quartiles as the cut-off values (see Table 2). The presence of other dogs in the

**Table 1**
Frequency of reports of health problems and behavioural concerns by owners of former CBE breeders and matched pet owners.

| | CBE ex-breeding dogs | Matched controls |
|---|---|---|
| *Health problems* | | |
| Yes | 78(24)[a] | 55(17) |
| No | 254(77) | 277(83) |
| *Behavioural concerns* | | |
| No problems | 56(17) | 146(44) |
| Only minor problems | 166(50) | 119(36) |
| Moderate problems | 90(27) | 53(16) |
| Serious problems | 20(6) | 14(4) |
| Total | 332 | 332 |

[a] Numbers in parentheses indicate percentages within each dataset.

**Table 2**
Quartiles used to create discrete ordinal categories for each of the 14 subscales. Scores at or below each cutoff value were recoded as indicated in the column header. Numbers in parentheses indicate the number of questions that comprise each subscale.

| C-BARQ subscale | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Stranger-directed aggression (10) | 0 | 0.2 | 0.8 | >0.8 |
| Owner-directed aggression (8) | 0 | 0.125 | >0.125 | n/a[a] |
| Dog-directed aggression (4) | 0 | 0.25 | 1.0 | >1.0 |
| Dog rivalry (4) | 0 | 0.25 | 0.75 | >0.75 |
| Trainability (8) | 1.75 | 2.25 | 2.75 | >2.75 |
| Chasing (4) | 0.25 | 1.5 | 2.5 | >2.5 |
| Stranger-directed fear (4) | 0 | 1.0 | 2.75 | >2.75 |
| Dog-directed fear (4) | 0.25 | 0.75 | 1.667 | >1.667 |
| Nonsocial fear (6) | 0.5 | 1.083 | 2.0 | >2.0 |
| Separation-related problems (8) | 0.125 | 0.5 | 1.0 | >1.0 |
| Touch sensitivity (4) | 0.25 | 1.0 | 1.67 | >1.67 |
| Excitability (6) | 1.5 | 2.0 | 2.67 | >2.67 |
| Attachment/attention-seeking (6) | 1.5 | 2.0 | 2.67 | >2.67 |
| Energy (2) | 1.0 | 1.5 | 2.5 | >2.5 |

[a] The first and second quartiles had the value of 0, therefore only 3 categories were formed.

**Table 3**
Results of the ordinal Generalized Linear Models. *P* values represent the main effect of being a former CBE breeding dog.

| Response variable | *P* | Odds ratio | *B* | SE | 95% CI | Confounders[b] |
|---|---|---|---|---|---|---|
| **Escapes**[a] | 0.002 | 0.56 | −0.571 | 0.183 | (−0.929, −0.212) | |
| Rolls in feces | 0.009 | 0.62 | −0.473 | 0.183 | (−0.831, −0.116) | |
| Coprophagia | 0.013 | 1.58 | 0.455 | 0.183 | (0.098, 0.813) | 1 |
| Chews | 0.701 | | | | | 3 |
| Mounts | 0.015 | 0.53 | −0.629 | 0.258 | (−1.135, −0.124) | |
| **Begs** | 0.003 | 0.60 | −0.512 | 0.173 | (−0.851, −0.173) | **1** |
| Steals food | 0.011 | 0.63 | −0.466 | 0.183 | (−0.824, −0.108) | 2 |
| **Nervous on stairs** | <0.0001 | 5.98 | 1.789 | 0.222 | (1.353, 2.225) | |
| **Pulls on leash** | 0.0002 | 0.51 | −0.679 | 0.183 | (−1.037, −0.320) | **1**, 3 |
| **Urine marking** | 0.001 | 2.06 | 0.724 | 0.222 | (0.290, 1.159) | 1, 2 |
| Emotional urination | 0.959 | | | | | |
| **Urination when left alone** | <0.0001 | 2.81 | 1.032 | 0.197 | (0.647, 1.416) | 2 |
| **Defecation when left alone** | 0.0003 | 2.07 | 0.726 | 0.202 | (0.331, 1.121) | 2 |
| Hyperactive | 0.012 | 0.62 | −0.482 | 0.191 | (−0.856, −0.108) | **3** |
| **Stares intently at nothing visible** | 0.003 | 1.87 | 0.626 | 0.210 | (0.215, 1.037) | 1 |
| Snaps at flies | 0.257 | | | | | |
| Tail chasing | 0.011 | 0.50 | −0.688 | 0.269 | (−1.216, −0.160) | **1**, **3** |
| **Shadow chasing** | 0.001 | 0.40 | −0.927 | 0.282 | (−1.481, −0.373) | 1 |
| Barks persistently | 0.004 | 0.61 | −0.501 | 0.174 | (−0.842, −0.159) | |
| Self grooming | 0.007 | 1.65 | 0.499 | 0.186 | (0.135, 0.864) | 1, 3 |
| Allo grooming | 0.072 | | | | | 1 |
| Other stereotyped behaviour | 0.005 | 1.91 | 0.648 | 0.229 | (0.199, 1.098) | |
| **Stranger-directed aggression** | <0.0001 | 0.40 | −0.942 | 0.183 | (−1.299, −0.585) | 1 |
| Owner-directed aggression | 0.004 | 0.55 | −0.606 | 0.211 | (−1.020, −0.191) | **1** |
| **Dog-directed aggression** | <0.0001 | 0.30 | −1.202 | 0.188 | (−1.569, −0.834) | |
| **Dog rivalry** | <0.0001 | 0.42 | −0.864 | 0.191 | (−1.237, −0.490) | |
| Separation-related problems | 0.093 | | | | | 1 |
| **Trainability** | <0.0001 | 0.25 | −1.370 | 0.186 | (−1.734, −1.006) | |
| **Chasing small animals** | <0.0001 | 0.20 | −1.623 | 0.195 | (−2.004, −1.242) | |
| **Stranger-directed fear** | <0.0001 | 8.12 | 2.094 | 0.195 | (1.712, 2.476) | |
| **Dog-directed fear** | 0.002 | 1.78 | 0.577 | 0.183 | (0.220, 0.835) | 1 |
| **Nonsocial fear** | <0.0001 | 6.62 | 1.89 | 0.193 | (1.511, 2.269) | |
| **Touch sensitivity** | <0.0001 | 3.19 | 1.161 | 0.182 | (0.803, 1.518) | |
| **Excitability** | <0.0001 | 0.47 | −0.761 | 0.179 | (−1.112, −0.409) | |
| Attachment/attention-seeking | 0.846 | | | | | **3** |
| **Energy** | <0.0001 | 0.29 | −1.253 | 0.184 | (−1.614, −0.893) | **3** |

[a] Items in boldface are significantly different after sequential Bonferroni correction.
[b] Confounders with main effects: 1 = other dogs in household, 2 = neuter status, 3 = duration of ownership. Boldface indicates significance with sequential Bonferroni correction.

home (other dogs; yes/no), the length of time in the home (duration of ownership in months), and neuter status were also included as potential confounding effects. The latter was included because it was not possible to match every case with respect to neuter status. The CBE ex-breeding dog dataset contained four intact dogs (two male, two female) while the matched control dataset contained 20 intact dogs (15 female, 5 male). The remaining dogs were all neutered at the time of evaluation and both intact and neutered dogs were included in the analyses. Due to the severe imbalance or skewed nature of the confounding variables, interaction terms could not be included without encountering quasi-complete separation of the data; therefore, only main effects were included in the models.

Significant differences were found between CBE ex-breeding dogs and matched controls for 20 out of 36 behavioural variables measured by the C-BARQ (see Table 3). In general, CBE ex-breeding dogs exhibited more fear/nervousness, compulsive behaviours (defined as behaviours that are usually brought on by conflict, but subsequently displayed out of context and are often repetitive, exaggerated or sustained' (Hewson and Luescher, 1996), e.g., staring at nothing visible), house soiling when left alone, and sensitivity to touch compared to matched controls, and less aggression, excitability, energy, chasing small animals, and escaping/roaming. Most notably, CBE ex-breeding dogs showed markedly higher levels of fear. Compared to matched controls, the odds of scoring in the upper quartiles for stranger-directed fear were more than eight times higher in CBE ex-breeding dogs while holding the intervening variables constant. Likewise, the odds of scoring in the upper quartiles for nonsocial fear or receiving a higher scale score for 'nervous on stairs' were nearly six times greater for CBE ex-breeding dogs compared to matched controls. In addition, scoring in the upper quartiles for trainability (which would indicate a dog that is more easily trained) was 75% less likely for CBE ex-breeding dogs compared to matched controls when the intervening variables were held constant.

CBE ex-breeding dogs showed significantly lower levels of aggression compared to matched controls. They were 60% less likely to score in the upper quartiles for aggression directed toward strangers than matched controls when intervening variables were held constant. CBE ex-breeding dogs also scored lower for aggression directed toward other dogs (58% and 70% less likely to score in the upper quartiles for aggression toward familiar and unfamiliar dogs, respectively). Likewise, CBE ex-breeding dogs were 71%

and 53% less likely than matched controls to score in the upper quartiles for energy level and excitability, respectively. CBE ex-breeding dogs were 80% less likely to score in the upper quartiles for chasing small animals compared to matched controls when intervening variables were held constant.

The presence or absence of other dogs in the household had a significant main effect on a number of behaviours (Table 3), with dogs living in multi-dog households scoring more favorably than dogs in single-dog homes for all but coprophagia and urine marking. Neuter status had only marginal effects (Table 3), with intact dogs scoring less favorably, that did not reach statistical significance when corrections for multiple comparisons were made. The duration of time in the household also had a number of effects on behaviour, with increased time in the home associated with improved behaviour for all except self-grooming (Table 3).

## 4. Discussion

The psychological state that most obviously distinguishes former CBE breeding dogs from typical pet dogs is fear. As determined by their numerical scores on most of the C-BARQ fear subscales (fear of strangers, fear of stairs, nonsocial fears, and touch sensitivity), many of these dogs appear to experience regular and often persistent fear or anxiety, even after years in their adoptive households. The psychological composition of elevated fears toward unfamiliar people and dogs while demonstrating decreased aggression toward the same would tend to indicate chronic up-regulation of the hypothalamic–pituitary axis (HPA) "fight or flight" mechanism with a bias toward flight. In addition, CBE ex-breeding dogs exhibited significantly higher frequencies of house-soiling (urination and defecation when left alone, and urine marking) and compulsive behaviours, and significantly reduced scores for aggression, trainability, chasing small animals, excitability, and energy.

The abnormal behaviours (as compared to the control population) observed in the former CBE breeding dogs in this study have multiple potential causes. However, the two explanations most consistent with the findings are stress-induced psychopathology and inadequate early socialization and/or lack of exposure to environmental stimuli normally found in the lives of typical pet dogs.

### 4.1. Stress-induced psychopathology

Although no studies on sources of stress in CBEs or their potential effects on the well-being of the dogs have been published, these factors have been investigated in dogs living in confinement in kennels (Beerda et al., 1999a,b; Hiby et al., 2006; Lefebvre et al., 2009; Rooney et al., 2007; Stephen and Ledger, 2005; Taylor and Mills, 2007), animal shelters (Tuber et al., 1999; Wells et al., 2002), and laboratories (Campbell et al., 1988; Hubrecht, 1993; Hughes et al., 1989). Similar stressors have been documented in the CBE environment (USDA, 2004), and it is therefore reasonable to presume that the findings for dogs confined in kennels, shelters, and laboratories are applicable to the dogs in the present study, despite some differences in background, housing and husbandry. Specific factors that have been determined to be associated with stress in dogs living in confined environments include: spatial restriction (Beerda et al., 1999a,b; Wells et al., 2002); extreme temperatures (Morgan and Tromborg, 2007; Smalley, 2009; USDA, 2004); aversive interactions with kennel staff (Morgan and Tromborg, 2007; Scott and Fuller, 1965); lack of 'control' or the capacity to avoid or regulate exposure to aversive stimuli (Stephen and Ledger, 2005; Taylor and Mills, 2007; Tuber et al., 1999; Wells et al., 2002), and limited access to positive human and conspecific social interactions (Beerda et al., 1999a; Hubrecht, 1993; Hubrecht et al., 1992; Hughes et al., 1989).

The fact that dogs used for breeding purposes in CBEs typically live for years in the facility raises the issue of chronicity of stressor exposure; specifically, whether the kennel and shelter-related stressors just discussed are, when experienced chronically, sufficient for causing psychopathological changes in dogs. Recent studies in humans have demonstrated that chronic adversity in people has the potential to create profound emotional scars that may affect the individual for the remainder of his or her life (Niederland, 1964; van der Kolk et al., 2005). Chronic stress in dogs in kennel and shelter environments has been the subject of a few studies. Beerda et al. (2000) reported that dogs unable to cope successfully with inadequate housing conditions may become chronically stressed, as indicated by physiological indices and behaviour. The dogs may develop abnormal behaviours such as hyperactivity, timidity, aggression, and stereotypic locomotory behaviours (circling, pacing, and wall-bouncing) (Hubrecht, 1992; Hubrecht et al., 1992).

Physical health problems were reported at significantly higher rates among owners of former CBE breeding dogs than for matched controls. This may simply reflect substandard health care while in the CBE; however, adverse effects of stress on physical health are well-documented (Riley, 1981; Weiss, 1972) and numerous studies in humans and other animals have determined that exposure to chronic stress or traumatic events is associated with poor physical health and increased susceptibility to disease (Broom and Kirkden, 2004; Krause et al., 2004). Such effects may act over lengthy periods: longitudinal research shows that adverse and traumatic childhood experiences may impair physical health into adulthood (Edwards et al., 2003).

### 4.2. Inadequate socialization

The second major potential cause of many of the signs observed in the dogs in the present study is inadequate socialization and/or insufficient exposure to environmental stimuli during the first few months of life. The sensitive period for socialization occurs during the first 4 months of life (Scott and Fuller, 1965; Serpell and Jagoe, 1995), and, with rare exceptions, CBE breeding dogs are themselves conceived, born, and raised in CBEs, and live in CBEs throughout their sensitive periods (Hughes, personal communication, 2009). Various early experimental studies have demonstrated that young dogs reared in socially and environmentally impoverished conditions during the first 4–6 months subsequently have great difficulty adapting

to novel environments. Dogs reared entirely in kennels, for example, exhibit a condition—sometimes known as 'kennel-dog syndrome'—characterized by extreme fear and timidity when subsequently exposed to unfamiliar social interactions or environments (Clarke et al., 1951; Melzack and Thompson, 1956; Panksepp et al., 1983; Scott and Fuller, 1965; Serpell and Jagoe, 1995). Other studies have indicated that pups that are socially isolated from 3 days to 20 weeks of age are disturbed for life (Agrawal et al., 1967) and have impaired learning ability (Melzack and Scott, 1957). These effects of exposure to restricted early rearing conditions are usually extremely persistent and resistant to rehabilitation (Panksepp et al., 1983), an outcome that may be due to irreversible alterations in the structure and complexity of the developing brain (Serpell et al., 2006).

As a group, the CBE dogs in the present study exhibit a variety of abnormal behaviours consistent with the effects of poor socialization and stimulus deprivation in early life (Freedman et al., 1961; Scott and Fuller, 1965; Serpell and Jagoe, 1995). These include extreme fear responses to anyone or anything unfamiliar, compulsive or stereotypic behaviours, and reduced trainability (due to either cognitive deficits or an inability to relate properly to humans). Other unusual aspects of their behaviour, including exceptionally low levels of aggression, chasing small animals, energy and excitability (reactivity), and increased touch sensitivity, fear of stairs, and house-soiling, could also be plausibly attributed to lack of relevant environmental experience during appropriate sensitive periods in early development (Serpell and Jagoe, 1995).

### *4.3. Other potential causes of psychobehavioural abnormalities in former CBE dogs*

In view of the fact that the prenatal life of breeding dogs occurs in CBEs, the conditions and events during this period may play a role in the psychological development of the fetus. The effects on the developing offspring of stress experienced by the pregnant mother have been the subject of a large body of research. Offspring of pregnant animals exposed to various stressors have been documented with neurohormonal dysfunction (Seckl, 2004) and dysregulation of the HPA axis (Dickerson et al., 2005); abnormal response to (Henry et al., 1994), increased sensitivity to (Mastorci et al., 2009), and impaired ability to cope with stress (Braastad, 1998); exaggerated distress responses to aversive events (Morgan and Thayer, 1997); impaired learning (Nishio et al., 2001); abnormal social behaviour (Clarke and Schneider, 1993); increased emotionality and fear-related behaviour (Lehmann et al., 2000) and fearful behaviours that increase with increasing age (Dickerson et al., 2005); increased susceptibility to pathophysiological outcomes when further adversity occurs during adulthood (Mastorci et al., 2009); and behavioural deficits and molecular changes in the offspring similar to those in schizophrenic humans (Lee et al., 2007).

Longitudinal research in humans shows that adverse and traumatic childhood experiences—or, early life adversity (ELA)—impair mental and physical health into adulthood (Edwards et al., 2003). Studies in humans have identified ELA as a major risk factor for many serious adult mental health problems, such as unstable social relationships and anxiety and depressive mood disorders (Heim et al., 2002; Shea et al., 2005). Evidence from studies of human (Edwards et al., 2003) and nonhuman (Ladd et al., 2000) animals supports the thesis that ELA has extensive and enduring effects with strong correlations to the development of psychopathology later in life. Several rodent and primate models of ELA, including those that model maternal separation or loss, abuse, neglect, and social deprivation, have demonstrated that early experiences of major adversity are associated with long-term alterations in neuroendocrine responsiveness to stress, emotional and behavioural regulation, coping style, cognitive function, quality of social affiliations and relationships, and expression levels of nervous system genes shown to be associated with anxiety and mood disorders (Cohen et al., 2006; Sanchez et al., 2001).

Canine studies of the long-term effects of ELA are scarce. In their influential work on behavioural genetics in dogs, Scott and Fuller (1965) wrote that "the emotional sensitivity of the puppy during the period of socialization suggests that this period might also be a critical one for permanent psychological damage." Subsequently, Fox and Stelzner (1966) were able to demonstrate a short period at approximately 8 weeks when puppies were hypersensitive to distressing psychological or physical stimuli, and during which a single unpleasant experience could produce long-term aversive or abnormal effects. They concluded that during this brief period of puppyhood, dogs are particularly vulnerable to psychological damage. As a result of being raised in the CBE environment, the dogs in this study were presumably exposed to the stressors inherent in this environment during the early developmental stage of their lives. Consequently, the origins of the psychological changes recognized in this study may also be traceable to stressful events of the dogs' early life.

In summary, multiple factors may by themselves or in combination play a contributory role in the psychobehavioural abnormalities seen in the former breeding dogs from CBEs. However, the data are unable to determine specific causative relationships.

A final, and crucial, point of discussion is that anecdotal evidence as well as unpublished data on 878 of the dogs in this study show that many of the ex-CBO dogs can and will overcome much of the increased levels of fear through dedicated behavioural therapy and extreme patience on the part of the dogs' adoptive owners. Because of the large degree of success in rehabilitation we wish to make it clear that these dogs are not to be avoided as pets. Further, because of the fact that many of the dogs improve over time and were likely to have been in an improved state when they were entered in the study, the differences revealed in this study are possibly an underestimate of the full extent of the effects of CBE life.

## 5. Limitations

It is important to acknowledge the potential limitations of the current findings. Both CBE ex-breeding dogs and matched control samples were self-selected and may therefore be unrepresentative of the populations from

which they were drawn. Also, while every effort was made to match the pet dog and CBE samples, participants were recruited in different ways, and the samples differed from each other in other important respects (e.g., reproductive history, etc.). These differences may have contributed in unknown ways to the observed differences in C-BARQ scores. We also cannot rule out the possibility that a small proportion of the dogs in the matched control sample came originally from CBEs. However, if some of the controls were formerly from CBEs, the expectation would be that this would create more overlap between the two populations, thus reducing the size of any observed differences. Therefore, if anything, the differences reported in the present study are conservative estimates of the effects of being former CBE breeding dogs. In addition, the adoptive owners of former CBE breeding dogs were aware of the purpose of the study and may therefore have been sensitized to, and more likely to report, any unusual behaviour of their dogs when compared to the pet owners.

## 6. Conclusions

Substantial anecdotal evidence suggests that the welfare of dogs in commercial breeding establishments (or puppy mills) is poor, but scientific evidence has heretofore been lacking. By demonstrating that dogs maintained in these environments were reported to have developed long-term fears and phobias, compulsive behaviours such as circling and pacing, possible learning deficits, and are often unable to cope fully with normal existence, this study provides the first clear quantitative evidence that dogs confined in CBEs for breeding purposes demonstrate impaired mental health and, as a result, diminished welfare.

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## Conflicts of interest

The authors declare that no conflict of interest exists in which any author or authors' institution has a financial or other relationship with other people or organizations that may inappropriately influence the authors' work.

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Reviews

# Behavioral and psychological outcomes for dogs sold as puppies through pet stores and/or born in commercial breeding establishments: Current knowledge and putative causes

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ABSTRACT

A review of 7 published studies and 1 anecdotal report involving dogs born in high-volume commercial breeding establishments and sold to the consumer directly via the Internet or indirectly through retail pet stores revealed an increased incidence of behavioral and emotional problems that cause distress in adulthood compared with dogs from other sources, especially noncommercial breeders. The most consistent finding among studies is an increase in aggression, which is most commonly directed toward the dog's owners and family members but also to unfamiliar people, and other dogs. Increased fear was also identified in response to unfamiliar people, children, other dogs, nonsocial stimuli, and when taken on walks. Undesirable behaviors related to separation and/or attention seeking and a heightened sensitivity to touch have been reported. Because of how dogs sold through pet stores and/or born in commercial breeding establishments are bred, housed, weaned, transported, handled, homed, and raised, potential contributing factors for these reported outcomes are numerous. Some key factors include genetics, early-life stimulus deprivation (inadequate stimulus exposure, inappropriate or lack of social exposure), stress (prenatal maternal stress and postnatal early-life adversity), early weaning and maternal separation, transport and pet-store-related factors, and owner-related factors such as inadequate knowledge and experience with dogs as well as different levels of commitment to the pet dog. All published studies suggest a role for major stressors during puppy development from the prenatal stage through adolescence in the development of many behavioral problems. Accordingly, for any dog breeding operation, a standard of care that adequately redresses the welfare of the mother and pups and the risk of later behavior problems attendant with early stress and distress need to be formulated and followed in a manner supported by the emerging data.



## Introduction

Events occurring in the early developmental stages of mammalian life beginning *in utero* can have profound and lifelong effects on an individual's psychological and behavioral characteristics (Sanchez et al., 2001; Lupien et al., 2009). Recent theory has suggested that changes induced *in utero* may have adaptive value by preparing the newborn for the environmental challenges faced by the mother (Braastad, 1998). However, most experimental studies on nonhuman animals and clinical studies of humans suggest that *in utero* stress results in dysregulation of the hypothalamic-pituitary-adrenal (HPA) axis, dysfunction, and poor coping abilities. In companion animals, adverse changes that include increased fearfulness and emotionality, impaired adaptation to conditions of conflict or aversion, and cognitive alterations including learning deficits, and diminished attention span (Braastad, 1998; Huizink et al., 2004; Beydoun & Saftlas, 2008) would impair suitability of the animal to the new home environment. Behaviors in adult dogs that are undesirable, abnormal, unhealthy, or simply atypical for that particular age, sex, or breed have

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many causes (e.g., Scott & Fuller, 1965, pp. 110-112, 118; Fox & Stelzner, 1966; Slabbert & Rasa, 1993; Jagoe, 1994; Braastad et al., 1998; Serpell & Duffy, 2016).

Studies published during the past 23 years have suggested that dogs sold through pet stores and/or born in high-volume, commercial breeding establishments (CBEs) show an increased number of problem behaviors as adults. Most puppies sold by pet stores in the United States are purchased from brokers, who acquire their puppies from CBEs located throughout the United States (Hunte Corporation, 2016). A similar situation has been reported in Europe, where breeding operations in Hungary and Slovakia supply puppies for the continent (FOUR PAWS International, 2016). It should be noted that there are no scientifically validated, internationally recognized standards for such organizations. Conditions in the CBEs are reported to vary widely, ranging from relatively clean to squalid, noxious, and gravely detrimental to animal health and welfare (USDA, 2004; USDA, Office of Inspector General, 2010; Ferrari & Antonioli, 2016; USDA, 2016). CBEs are characterized by large numbers of dogs, maximal efficiency of space by housing dogs in or near the minimum space permitted by law, breeding dogs spending their entire reproductive lives in their cages or runs, group and solitary housing, dogs rarely if ever permitted out of their primary enclosures for exercise or play, no toys or enrichment, minimal-to-no positive human interaction/companionship, and inadequate health care. Commonly reported conditions present in many but not all CBEs include cage flooring made of wire mesh, accumulation of feces, ammonia odor, no windows and poor ventilation, inadequate protection from inclement weather and temperature extremes, insufficient or contaminated water and spoiled food, serious untreated medical conditions (e.g., advanced dental disease), extensive matting of hair, commonness and apparency of stereotypical behaviors, evidence of starvation, and presence of deceased adult dogs and puppies (USDA, 2004; USDA, Office of Inspector General, 2010; Ferrari & Antonioli, 2016; USDA, 2016).

De Meester et al. (2005) evaluated the conditions and practices in Belgian breeding kennels to determine whether they met the recommendations advocated in the scientific literature for separation of puppies from their mother and littermates (Slabbert & Rosa, 1993; Pierantoni et al., 2011; Overall, 2013, pp. 127-128) and exposure to various social and nonsocial stimuli (Melzack & Thompson, 1956; Melzack & Scott, 1957; Freedman et al., 1961; Scott & Fuller, 1965, pp. 101-108; Fuller & Clark, 1966; Fuller, 1967; Gazzano et al., 2008a). The investigators found both major and minor deviations from the recommended standards in the 48 kennels included in the study. Weaning frequently occurred when the puppies were too young, many puppies never left their kennel confinement and had little or no contact with unfamiliar humans, and puppies were often provided little visual, olfactory, and acoustic stimulation/enrichment or toys.

The aim of this review was to summarize the published data on the behaviors of dogs obtained from pet stores and/or born in CBEs, compared with dogs obtained from other sources, and to examine putative causes for common behavioral problems that have been identified as occurring disproportionately in pet store dogs.

## Results from studies

A total of 7 studies surveying populations of dogs in the United Kingdom (Jagoe, 1994; Casey et al, 2014; Gray et al, 2016), Australia (Bennett and Rohlf, 2007), Italy (Pierantoni et al, 2011; Pirrone et al, 2016), and the United States/internationally (McMillan et al, 2013) were identified. Key features of the studies are summarized in Table 1.

In a retrospective survey of 737 mature dogs, Jagoe (1994) investigated the relationship between early-life experience and owner-reported behavior problems in adulthood. The dogs' owners completed a questionnaire that inquired about (1) the frequency with which the dog displayed any of 40 possible behavior problems; (2) the dog's early experiences and environment from birth to 16 weeks of age (e.g., details of any early health problems, time left alone as a puppy during the day, the puppy's age when acquired, source, its age at first vaccination, and the age when it was first taken out into public areas on a regular basis); and (3) the owners themselves and their household. There were 451 dogs with reported behavior problems and 286 dogs without reported behavior problems.

Twenty dogs (2.7%) were acquired from pet stores. When sources were compared, dogs obtained from pet shops were overrepresented in the group of dogs with certain behavior problems, compared with those obtained from breeders, friends or relatives, or bred at home (Table 1). "Dominance-type" aggression (aggression directed toward people, especially the dog's owner and owner's family members) was more common among dogs acquired from pet stores (11/20; 55%), compared with animal shelters (34/129; 26.4%), found (15/43; 34.9%), breeders (119/394; 30.2%), friends or relatives (21/99; 21.2%), or bred at home (10/49; 20.4%, $P = 0.02$). Pet store–acquired dogs also more often demonstrated social fears (fear of strangers, children, and unfamiliar dogs) compared with dogs from other sources (Table 1).

Bennett and Rohlf (2007) studied the frequency of potential problem behaviors reported by owners in a convenience sample of 413 companion dogs, 47 of which were obtained from pet stores. Scores calculated using a principal component analysis from the questionnaires yielded 5 behavioral subscales: "disobedient," "unfriendly/aggressive," "nervous," "anxious/destructive," and "excitable." Mean scores on the unfriendly/aggressive subscale were significantly higher for dogs obtained from pet stores (8.70) and animal shelters (7.83) compared with dogs obtained from breeders (5.61, $P \leq 0.01$). Dogs obtained from pet stores had significantly higher mean scores on the "nervous" behavioral subscale than dogs who were home-bred (7.50 vs. 4.80, $P \leq 0.05$). All sources of dogs had higher mean scores on the excitability subscale than home-bred dogs ($P \leq 0.05$), and mean scores were not significantly different across sources for disobedience, anxious/destructive, or excessive barking subscales (Table 1).

Pierantoni et al. (2011) compared owner-reported behaviors of 70 adult dogs separated from their mother and littermates at 30-40 days of age and the behaviors of 70 adult dogs separated at 2 months of age. Overall, 71 dogs came from pet stores. Although the source of the dog was not directly associated with or a predictor for reports of specific problem behaviors, the frequency of certain behaviors (fearfulness on walks, aversion to strangers, destructiveness, excessive barking, attention-seeking behaviors, toy possessiveness, and play biting) among dogs separated from their mother and littermates at the earlier age was higher if they came from pet shops rather than from other sources (Table 1). For example, 80% of dogs separated early from litters and obtained from pet stores exhibited destructiveness more frequently compared to 20% of dogs not separated early.

McMillan et al. (2013) compared the owner-reported behavioral characteristics in dogs obtained as puppies from pet stores and dogs obtained as puppies from noncommercial breeders. Using the Canine Behavioral Assessment and Research Questionnaire (C-BARQ; Hsu & Serpell, 2003), 413 adult dogs obtained as puppies from pet stores were compared to 5,657 dogs obtained as puppies from noncommercial breeders. Results of multiple regression analyses revealed that dogs acquired from pet stores were in general more excitable ($P < 0.001$), energetic ($P = 0.043$), more attached/attention seeking ($P < 0.001$), and less trainable ($P < 0.001$) than dogs from breeders. Sexually intact pet store dogs were 3 times as

**Table 1**
Published reports involving dogs sold through pet stores and/or born in commercial breeding

| Reference | Type of study and population | Sample size and source of dogs | Primary goal of the study | Outcomes | Findings relevant to pet stores and/or CBEs |
|---|---|---|---|---|---|
| Jagoe 1994 | Retrospective survey of owner-reported behavior of dogs visiting behavior consultants in England and Wales; a random sample of dog owners in the area of Cambridge, United Kingdom; owners visiting any of 11 veterinary practices; and owners of dogs referred for medical reasons to the Cambridge University Veterinary Hospital | Total n = 737; BR, n = 394; F/R, n = 99; AS, n = 129; PS, n = 20; F/U, n = 43; HB, n = 49 | Investigate variables associated with behavior problems | Data indicate the proportion of dogs from each source reported as having the behavior indicated and *P*-values for Pearson chi-square:<br>"Dominance-type" aggression: BR, 119/394 (30.2%); F/R, 21/99 (21.2%); AS, 34/129 (26.4%); PS, 11/20 (55%); F/U, 15/43 (34.9%); HB, 10/49 (20.4%); $P = 0.02$ | Owner-directed aggression and social fears (fear of strangers, children, and unfamiliar dogs) were significantly more prevalent than expected among dogs acquired from pet stores than dogs from other sources. |
| Bennett and Rohlf 2007 | Cross-sectional survey of a convenience sample of dog owners recruited from pet stores and veterinary clinics in Australia | Total n = 413; BR, 50.1%; AS, 14.3%; PS, 11.4%; F/R, 10.7%; ST, 9.2%; HB, 2.4% | Ascertain the frequency of canine behavior problems and any association with demographic variables and other characteristics of dog–owner interaction | Data are scores on behavioral subscales, with higher scores indicating a greater perceived incidence of the behavior<br>Unfriendly/aggressive (PS, 8.70, $P <$ 0.01; BR, 5.61; AS, 7.83 $P < 0.01$); F/R, 7.75; HB, 8.20; ST, 5.84) (reference category is BR for *P*-values)<br>Nervous (PS, 7.50, $P < 0.05$; BR, 5.49; AS, 6.18; F/R, 5.02; HB, 4.80; ST, 5.58) (reference category is SB for *P*-values)<br>Excitable (PS, 3.81, $P < 0.05$; BR, 3.28, $P < 0.05$; AS, 3.58, $P < 0.05$; F/R, 3.64, $P < 0.05$; HB, 2.00; ST, 2.47, $P < 0.05$) (reference category is SB for *P*-values)<br>Disobedience (NS across sources)<br>Anxious/destructive (NS across sources)<br>Barks excessively (NS across sources) | Dogs purchased from pet stores or shelters were considered by their owners to be more unfriendly or aggressive than were dogs purchased from breeders and significantly more nervous than dogs bred by the present owner. |
| Pierantoni et al. 2011 | Retrospective telephone survey of dog owners in Italy recruited from veterinary practices | PS, n = 71<br>F/R, n = 47<br>BR, n = 22 | Compare frequency of behaviors in dogs with early (30-40 days) versus late (60 days) separation from litter with source as a secondary outcome | Data indicate the proportion of responders from early separation (ES) versus nonearly separation (NES) groups indicating presence of the behavior only for dogs acquired from PS<br>Destructiveness: 80% versus 20%, $P = 0.017$<br>Excessive barking: 78% versus 22%, $P = 0.007$<br>Toy possessiveness: 100% versus 0%, $P = 0.000$<br>Fearfulness on walks: 91% versus 9%, $P = 0.001$<br>Attention seeking: 71% versus 29%, $P = 0.002$<br>Aversion to strangers: 80% versus 20%, $P = 0.005$<br>Play biting: 87% versus 13%, $P = 0.032$<br>NS: Reactivity to noises, food possessiveness, stranger aggression, owner aggression, tail chasing, paw licking, shadow staring, pica, house soiling | Overall, the source of the dog was not significantly associated with the behavioral categories examined. Among dogs obtained from pet stores, those who had been separated from the litter earlier were more likely to exhibit fearfulness on walks, aversion to strangers, destructiveness, excessive barking, attention-seeking behaviors, toy possessiveness, and play biting. |

| | | | | | |
|---|---|---|---|---|---|
| McMillan et al. 2013 | Cross-sectional Internet survey of a convenience sample of dog owners initially in the Philadelphia area and later without geographic restrictions using the C-BARQ | PS, n = 413; BR, n = 5,657 | Compare the frequency of behaviors for dogs obtained from PS versus BR | Data are OR [95% CI] for dogs from PS versus BR<br>Owner-directed aggression (intact dogs): 3.13 [1.87; 5.23], $P < 0.001$<br>Owner-directed aggression (neutered dogs): 1.54 [1.16; 2.06], $P = 0.003$<br>Dog-directed aggression: 1.96 [1.44; 2.67], $P < 0.001$<br>Stranger-directed aggression: 1.59 [1.18; 2.16], $P = 0.003$<br>Dog rivalry: 1.35 [1.05; 1.74], $P = 0.021$<br>Dog-directed fear: 1.33 [1.03; 1.71], $P = 0.030$<br>Nonsocial fear: 1.44 [1.01; 2.07], $P = 0.047$<br>Separation-related behavior: 1.58 [1.19; 2.11], $P = 0.002$<br>Touch sensitivity: 1.58 [1.18; 2.11], $P = 0.002$<br>Escape behavior: 4.14 [1.75; 9.83]; $P = 0.001$ | Pet store–obtained dogs were reported to exhibit significantly greater aggression toward owner and family members, unfamiliar people, and other dogs; greater fear of other dogs and nonsocial stimuli; greater separation-related problems and attention-seeking behavior, touch sensitivity, house soiling, escaping from the home, sexual mounting of people and objects, excitability, and lack of trainability. |
| Casey et al. 2014 | Cross-sectional survey of a convenience sample of United Kingdom dog owners | BR, n = 2,189; AS, n = 765; F/R, n = 144; HB, n = 386; other including PS, n = 384 | Investigate the number of dogs showing aggression to people and any relationship with co-occurring variables | Data are adjusted OR [95% CI] for aggression toward members of the family or household versus dogs from breeders as the reference category<br>AS, 2.638 [1.590; 4.376]<br>HB, 0.224 [0.054; 0.934]<br>F/R, 0.555 [0.132; 2.332]<br>Other (incl PS) 1.786 [1.067; 3.299] | Dogs acquired from "other" sources (which included pet stores and Internet sites) were 1.8 times as likely to show human-directed aggression as those obtained directly from breeders. |
| Pirrone et al. 2016 | Cross-sectional Internet survey of a convenience sample of dog owners in Italy | PS, n = 173; BR, n = 349 | Assess the frequency of potentially problematic behaviors in dogs acquired from pet stores versus official breeders | Data are frequency of owner-assessed problem behaviors for dogs from pet stores versus official breeders, respectively.<br>Separation-related behavior: 30% versus 17%, $P = 0.023$; OR [95% CI]: 1.997 [1.29; 3.532]<br>House soiling: 15% versus 5%, $P = 0.0004$; OR 3.081 [1.398; 6.974]<br>Body licking: 30% versus 14%, $P = 0.001$; OR 5.580 [1.440; 4.620]<br>Owner-directed aggression: 21% versus 10%, $P = 0.009$; OR 2.396 [1.227; 4.678]<br>NS: Destructiveness, excessive barking, fearfulness on walks, reactivity to noises, toy possessiveness, food possessiveness, attention seeking, aversion to strangers, stranger-directed aggression, dog-directed aggression, tail chasing, pica, or consumption of non–food-related objects | After adjusting for potential confounders, dogs obtained from pet stores were twice as likely to exhibit aggressive behavior toward owners than those obtained from official breeders. |

(*continued on next page*)

**Table 1** (*continued*)

| Reference | Type of study and population | Sample size and source of dogs | Primary goal of the study | Outcomes | Findings relevant to pet stores and/or CBEs |
|---|---|---|---|---|---|
| Gray et al, 2016 (Abstract) | Cross-sectional Internet survey of a convenience sample of owners using the C-BARQ of owners of 3 breeds of dogs (Chihuahua, n = 85; pug, n = 125; Jack Russell, n = 225) acquired in the United Kingdom | RBR n = 285; LRBR, n = 150 | Compare owner-reported behaviors for 3 breeds of dogs | Data are median owner-reported scores on ordinal scale from C-BARQ (0, none; to 4, serious for intensity) and (0, never; to 4, always for frequency) on >100 behavioral questions for dogs from responsible versus less-responsible breeders, respectively.<br>Chihuahua: Increased aggression toward familiar (0.3 vs. 0.8, $P$ = NS) and unfamiliar dogs (1.3 vs. 1.5, $P$ = NS), strangers (0.6 vs. 1.1, $P$ = NS), and owner (0.0 vs. 0.3, $P < 0.05$); stranger-directed fear (1.3 vs. 1.5, $P < 0.05$); touch sensitivity (0.8 vs. 1.8, $P < 0.05$); separation anxiety (0.6 vs. 0.9, $P < 0.05$); chasing (1.1 vs. 2.1, $P < 0.05$).<br>Pug: Fear of dogs (0.5 vs. 1.0, $P$ = NS); fear of stranger (0 vs 0, $P$ = NS); other fear 0.5 vs 0.9; separation anxiety (0.6 vs. 0.9, $P < 0.05$); familiar dog aggression (0.3 vs. 0.8, $P$ = NS); excitability (2.0 vs. 2.3, $P < 0.05$); energy (2.0 vs. 2.8, $P < 0.05$).<br>Jack Russell: Decreased trainability (2.5 vs. 2.1, $P < 0.05$). | Puppies from less-responsible breeders had less-favorable behavior traits as adults compared to puppies from responsible breeders |

AS, animal shelter; BR, noncommercial or hobby breeder; C-BARQ, Canine Behavioral Assessment and Research Questionnaire; CBEs, commercial breeding establishments; CI, confidence interval; NR, not reported; NS, not statistically significant; sources of dogs; CB, commercial breeder or puppy farm; F/R, friend or relative; F/U, found or unowned; HB, home bred; LRBR, less-responsible breeder; OR, odds ratio; PS, pet store; RBR, responsible breeder; ST, stray.

**Table 2**
Comparison of results from McMillan et al. (2013) and Pirrone et al. (2016)

| Factor differences as compared to noncommercial breeder-obtained dogs | Study A—McMillan et al. 2013 | Study B—Pirrone et al. 2016 |
|---|---|---|
| Elevated in both studies | Owner-directed aggression ↑ | Owner-directed aggression ↑ |
| Elevated in study A; elevated but with confounder in study B | Separation-related problems ↑ | ↔ (after correction for confounders) |
| | Most forms of house soiling ↑ | ↔ (after correction for confounders) |
| Not assessed in study A; elevated but with confounder in study B | NA | ↔ (after correction for confounders) |
| Elevated in study A; not elevated in study B | Stranger-directed aggression ↑ | Stranger-directed aggression ↔ |
| | Nonsocial fear ↑ | Fearfulness on walks ↔ |
| | | Reactivity to noises ↔ |
| | Attention-seeking behavior ↑ | Attention-seeking behavior ↔ |
| Elevated in study A; not assessed in study B | Dog-directed aggression (toward familiar and unfamiliar dogs) ↑ | NA |
| | Fear of dogs ↑ | NA |
| | Touch sensitivity ↑ | NA |
| | Excitability ↑ | NA |
| | Sexual mounting of people and objects ↑ | NA |
| | Escaping from the home ↑ | NA |
| | Less trainable ↑ | NA |
| Not elevated in study A; not assessed in study B | Chasing ↔ | NA |
| Not elevated in study A and study B | Stranger-directed fear ↔ | Aversion to strangers ↔ |
| Not assessed in study A; not elevated in study B | NA | Destructiveness ↔ |
| | NA | Excessive barking ↔ |
| | NA | Toy possessiveness ↔ |
| | NA | Food possessiveness ↔ |
| | NA | Tail chasing ↔ |
| | NA | Pica or consumption of non-food-related objects ↔ |

↑, elevated; ↔, no significant difference as compared to noncommercial breeder-obtained dogs; NA, not assessed.

likely to be reported showing owner-directed aggression as were sexually intact dogs acquired from breeders (odds ratio [95% confidence interval], 3.13 [1.87; 5.23]; $P < 0.001$), and pet store dogs were nearly twice as likely to be reported to have shown aggression toward unfamiliar dogs (dog-directed aggression) (odds ratio 1.96 [1.44; 2.67]; $P < 0.001$). Pet store dogs were also 30%-60% more likely to be reported to display stranger-directed aggression, dog-directed aggression, dog-directed fear, nonsocial fear, separation-related behaviors, escape behavior, and sensitivity to being touched (Table 1). Other behaviors reported more frequently in dogs from pet stores compared with breeders were sexual mounting of people and objects, most forms of house soiling (urination and defecation), and being less trainable (data not shown).

Using a cross-sectional convenience sample of United Kingdom dog owners, Casey et al. (2014) examined the demographic variables and risk factors associated with owner-reported aggressive behavior in dogs. The origin of the dog was a risk factor for aggression toward household members, with a 1.8 times increased risk of aggression toward family members in dogs from "other" sources (including pet shops) having an increased risk of aggression toward family members as compared to those obtained directly from breeders (odds ratio [95% CI], 1.786 [1.067; 3.299]). Dogs from animal shelters were also more likely to show aggression to family members (odds ratio [95% CI], 2.638 [1.590; 4.376]).

Pirrone et al. (2016) conducted a study to compare owner-assessed potential problem behaviors in 2 groups of dogs: those obtained from pet shops and those obtained from official Italian breeders recognized by the Italian Kennel Club (E.N.C.I). Owners completed an online version of the Relazione Cane-Proprietario questionnaire, which collects information about the dog owners (age, gender, marital status, education, presence of children, locality of residence, presence of a house yard, and former dog ownership), their dogs (breed, size, age, sex, sexual status, age at acquisition, and source), and whether the dogs exhibited any of 16 common, problematic behaviors (separation-related behavior, destructiveness, excessive barking, fearfulness on walks, reactivity to noises, toy possessiveness, food possessiveness, attention seeking, aversion to strangers, stranger-directed aggression, owner-directed aggression, dog-directed aggression, tail chasing, body licking, pica or consumption of non–food-related objects, and house soiling). Of

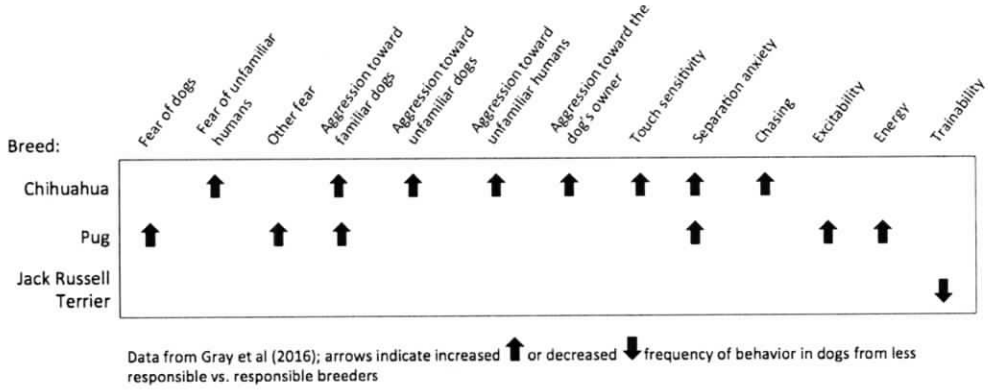


**Figure 1.** Relative frequency of behavior problems in dogs from less-responsible breeders compared with dogs from responsible breeders for 3 breeds of dogs.

522 dogs in the study, 349 were acquired as puppies from breeders and 173 from pet shops. Dogs from pet stores were more likely than dogs from breeders to have a statistically significant increased risk for 4 behaviors compared with dogs acquired from breeders: owner-directed aggression (odds ratio [95% CI], 2.396 [1.227; 4.678]); separation-related behaviors (odds ratio [95% CI], 1.997 [1.29; 3.532]); house soiling (odds ratio [95% CI], 3.081 [1.398; 6.974]); and body licking (odds ratio [95% CI], 5.580 [1.440; 4.620]) (Table 1). Owner-related factors that also were important included no experience with past dogs, nonattendance at training courses, lack of awareness of the existence of veterinary behaviorists, and short daily walks, suggesting that source of dog is often confounded with knowledge, experience, and behavior of owner.

Of the 13 factors found elevated by McMillan et al. (2013), Pirrone et al. (2016) found 2 elevated but with confounders (house soiling, separation-related behavior), 3 not elevated (stranger-directed aggression, nonsocial fear, attention-seeking behavior), and 1 elevated with no confounder (owner-directed aggression) (Table 2). Seven factors found elevated by McMillan et al. were not evaluated by Pirrone et al. (dog-directed aggression, fear of dogs, touch sensitivity, excitability, sexual mounting of people and objects, escaping from the home, and poor trainability). The single finding consistent between the studies was that obtaining puppies from pet stores represents a risk factor for developing owner-directed aggression as adult dogs.

Gray et al. (2016) investigated differences in the behaviors of adult dogs based on the assumed quality of the breeding operation. The study focused on 3 popular breeds—Chihuahua, pug, and Jack Russell terrier. Using the C-BARQ, the authors supplemented the standard C-BARQ questions with 11 additional questions designed to categorize the source of the dog as either a "responsible" or "less-responsible" breeder. The criteria included specifics about the source (small breeder, pet store, puppy farm), whether the dam was personally seen by the purchaser and seen interacting with her puppies, whether the breeder appeared to be caring and responsible and showed concern for puppies and dams' welfare, whether the puppies were in the breeder's home, the suitability of the dogs' housing, the number of litters available, whether health documents for the dogs and puppies were made available for review, and the age at which the puppy was purchased. The scoring of these factors formed the basis for classification into "responsible" or "less-responsible" breeder, where >3 concerns signified "less responsible."

Analysis of the C-BARQ average scores (range 0-5) for each behavioral category (analyzed using Mann–Whitney *U* tests for nonnormally distributed data) showed less-favorable scores for dogs acquired from the less-responsible breeders (see Table 1; Figure 1). Chihuahuas acquired from less-responsible breeders (n = 50; responsible breeders n = 35) were reported to show more aggression toward familiar dogs (median 0.8; 0.3), unfamiliar dogs (median 1.5; 1.3), unfamiliar humans (median 1.1; 0.6), and their owners (median 0.3; 0*). Additionally, Chihuahuas from less-responsible breeders showed more fear of unfamiliar humans (median 1.5; 1.3*), sensitivity to touch (median 1.8; 0.8*), separation-related behaviors (median 0.9; 0.6*), and chasing (median 2.1; 1.1*). Pugs from less-responsible breeders (responsible breeder: n = 85; less-responsible breeder: n = 40) were reported to show more fear of dogs (median 1.0; 0.5), other fear (median 1.0; 0.5), aggression toward familiar dogs (median 0.8; 0.3), separation-related behaviors (median 1.4; 0.5*), and excitability (2.3; 2.0*). Jack Russell terriers from less-responsible breeders (responsible breeder: n = 150; less-responsible breeder: n = 75) were reported to show a decrease in trainability as calculated through the C-BARQ score for this behavioral category (median 2.1; 2.5*—a higher score for this category is better, whereas for all other C-BARQ scores, a lower score is better). All results were significant at the $P < 0.05$ level, but only those marked * remained statistically significant at the $P < 0.05$ level after Holm's sequential Bonferroni adjustment was applied. The significant differences and the pattern of the remaining data do suggest that dogs from less-responsible breeders have a poorer behavioral profile for a companion animal (higher aggression and fear), reflecting poorer welfare (fear and separation anxiety).

If puppies were aged less than 8 weeks when purchased, they showed an increased likelihood of later exhibiting aggression and separation-related behaviors. In addition, dogs from breeders who had more than 1 litter to offer exhibited more fear and aggression in adulthood. Further research about specific behaviors and trajectories for behavioral development is needed, preferably using standardized, objective testing (e.g., Tiira and Lohi, 2014).

Finally, an anecdotally reported study presented in a book chapter described a sample of 1864 dogs exhibiting various behavioral problems found that 220 (approximately 12%) of the dogs displayed separation-related problems (Mugford, 1995). An analysis based on the source of the dog revealed that only 10% of purebred dogs obtained directly from breeders presented with separation-related problems, whereas "55% of purebred dogs originating from so-called 'puppy farms' or 'puppy mills'" (p. 142) presented with such problems. It was not reported how it was determined that the dogs came from puppy farms or puppy mills.

## Potential causes

For a puppy sold from a pet store in the United States, the typical succession of events presumed to be involved in shaping its future behavior involves the following: (1) selection of sire and dam, which determines the genotype of the puppy; (2) development of the fetus *in utero*, which is affected by the experiences of the mother while living in the CBE (Braastad, 1998; Braastad et al., 1998; Beydoun & Saftlas, 2008); (3) life in the breeding facility from birth to (by law) a minimum age of 8 weeks (Federal Register, 2008), (4) removal of the puppy from the mother, littermates, and its home environment; (5) transport of puppy from breeding facility to broker/distributor, including handling such as veterinary examinations, vaccinations, dewormings, and grooming at the broker/distributor (Hunte Corporation, 2016) (in direct Internet sales, this and subsequent steps instead consist of shipment directly to the purchaser and new home); (6) transport from broker/distributor to pet store; (7) the pet store environment; (8) relocation to purchaser's home; and (9) interactions with the home environment. During this series of events, the puppy is passing through 6 well-accepted periods of development: (1) the prenatal period (conception to birth); (2) the neonatal period (birth to 12 days); (3) the transition period (13-21 days); (4) the socialization period (3-12 weeks); and (5) the juvenile period (12 weeks to approx. 6 months); and (6) the adolescent period (approx. 6 months to 1-2 years) (Scott & Fuller, 1965, pp. 117-129) (Figure 2).

### *Genetics*

An animal's adult behavioral phenotype is determined by the interaction between the individual's genotype, experience, and developmental environment (Scott & Fuller, 1965, p. 293; Jacobs et al., 2004; Wilsson, 2016). Evidence supports a genetic component for psychobehavioral traits in dogs such as anxiety/fear, noise phobia, human aversion, obsessive-compulsive disorder, predatory behavior, and 2 types of aggression: impulse/control and conspecific (Murphree & Dykman, 1965; Overall & Dunham, 2002; Liinamo et al., 2007; Dodman et al., 2010; Pierantoni et al., 2011; Overall et al., 2016)—many of the behaviors demonstrated as

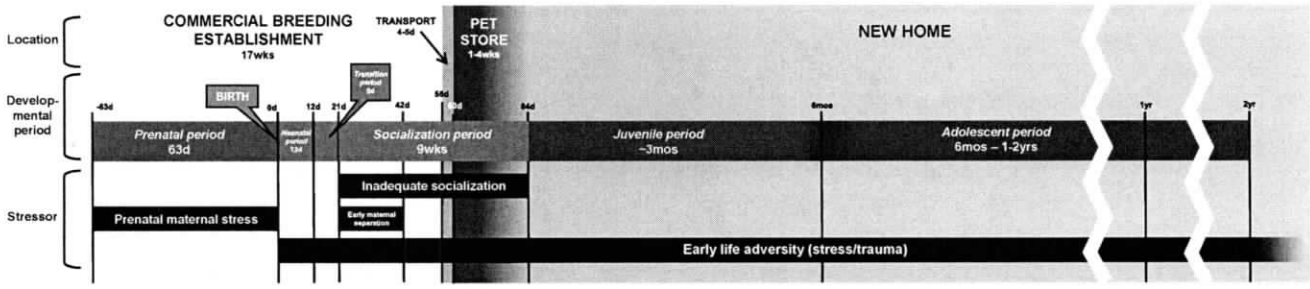


**Figure 2.** Chronology of developmental periods, living environment, and stressors in the United States. The age at which the puppies leave the breeding facility is often considerably earlier in other countries (and may also be earlier in the United States if there is not strict adherence to applicable law).

having a higher prevalence in CBE-produced dogs. Several literature reviews have been published, reporting ranges of heritability of behavioral traits in dogs varying from very low to very high; however, most reviews have found low or very low rates of heritability for most dog behaviors (Hall & Wynne, 2012; Overall et al., 2014; Hradecká et al., 2015). Genetics plays a role beyond the contribution to specific psychobehavioral characteristics, and there is compelling evidence from rodent and primate studies that the vulnerability for psychopathological outcomes from early-life trauma may be, at least in part, heritable. Studies in dogs (Foyer et al., 2013) and squirrel monkeys (Lyons et al., 1999) have demonstrated that the individual variability in coping and recovering from the aversive events has both a genetic and experiential component.

To the extent that genotype contributes to the development of adult behavioral phenotypes in dogs, the selection of dogs for breeding will influence such behavioral outcomes. It has been suggested by some authors that in high-volume CBEs, the pairing of sire and dam may occur with little regard for temperament (e.g., Lockwood, 1995; Bennett & Rohlf, 2007). A review of *The Kennel Spotlight*, the most widely read trade magazine for the high-volume commercial dog breeding industry, since 2007 revealed that no issue has included any information about selecting breeding pairs for temperament or behavioral traits or how to identify desirable temperament/behavioral traits in breeding dogs. The 1 pertinent article in this 10-year period—"Choosing Breeding Stock" by veterinarian Scott J. Gartner (2008)—discussed physical traits such as quality and length of hair coat, leg length, ear set, muscling, athleticism, and health (e.g., hernias, hip dysplasia, patella laxity, and heart murmurs) but did not mention of any traits related to temperament or behavior. That there is no valid, published industry standard for behavioral traits in puppies or breeding dogs is a concern.

### *Development and stress*

Physical and psychological experiences can have a profound effect, both positive and negative, on the developing organism (Scott & Fuller, 1965, pp. 110-112). A voluminous literature across many species has established that stress during the formative periods of neural development, from the prenatal stage through adolescence (Sterlemann et al., 2008; Serpell & Duffy, 2016), has a major influence on the ontogeny of behavior and that these effects are enduring and often lifelong (Lupien et al., 2009) (Figure 2). Indeed, a recent study (McMillan et al., 2011) on the mental health of dogs formerly used as breeding stock in CBEs found severe and long-lasting adverse effects on the behavior of dogs living in this type of environment. Other studies have shown that dogs living in confinement in kennels (Beerda et al., 1999a; Beerda et al., 1999b; Stephen & Ledger, 2005; Taylor & Mills, 2007), in animal shelters (Tuber et al., 1999; Wells et al., 2002), and in laboratories (Hughes et al., 1989; Hubrecht, 1993) may also experience a variety of stressors. These stressors include spatial restriction (Beerda et al., 1999a; Beerda et al., 1999b; Wells et al., 2002), extreme temperatures (Morgan & Tromborg, 2007), aversive interactions with kennel staff (Morgan & Tromborg, 2007), lack of perceived control or the capacity to avoid or regulate exposure to aversive stimuli (Tuber et al., 1999; Wells et al., 2002; Stephen & Ledger, 2005; Taylor & Mills, 2007), and limited opportunities for positive human and conspecific social interactions (Hughes et al., 1989; Hubrecht, 1993; Beerda et al., 1999a), all of which have been documented in the CBE environment (USDA, 2016). In the following sections, the effect of particular stressors during key periods of puppy development will be examined.

#### *Prenatal experiences*

Because of the sensitivity of the rapidly developing mammalian brain, physiological variations in the fetal environment caused by prenatal exposure to maternal stress—that is, stress experienced by a pregnant female—can have long-term consequences for psychological function which can manifest later in life in a wide range of pathological mental health and behavioral outcomes (Braastad, 1998; Huizink et al., 2004; Beydoun & Saftlas, 2008; Weinstock, 2008). These effects result largely from dysregulation of the HPA axis involving a decreased feedback inhibition of corticotropin-releasing hormone and prolonged elevation of plasma corticosteroids (Braastad, 1998; Weinstock, 2008).

Most research on the effects of prenatal experiences has been conducted in species other than canids. This work has demonstrated that maternal stress is associated with the following adverse effects among the offspring: impaired ability to cope with stress, maladaptive social behavior, increased fearfulness and emotionality, decreased exploratory behavior, impaired adaptation to conditions of conflict or aversion, latent inhibition (a model for schizophrenia and depression in human beings), and cognitive alterations including learning deficits and diminished attention span (Braastad, 1998; Huizink et al., 2004; Beydoun & Saftlas, 2008). Evidence of effects of prenatal stress in canid species is scarce. Braastad et al. (1998) studied the effects of prenatal maternal stress on the behavioral and hormonal development of offspring in blue foxes (*Alopex lagopus*). The stress treatment, conducted once daily during the last trimester of gestation (15 days), consisted of removing the pregnant female from her cage, holding her for 1 minute and then returning her to the cage. At 10 days of age, when compared to the young of unstressed mothers, the offspring of stressed mothers had elevated plasma levels of progesterone and cortisol as well as increased adrenal production of progesterone and cortisol, indicating enhanced HPA activity. When tested at 5 weeks of age in 3 tests for response to novelty, compared to control cubs, the prenatally stressed blue-fox cubs showed increased reactivity in all 3 tests: increased activity in an open field, more frequent reentry from a dark box into the open field, and more persistent activity when being held by a human (Braastad et al., 1998).

*Early-life experiences*

Postnatal influences of environmental stimulation on later behavior begin in the first 12 days of life—the neonatal period. A certain amount of stress is desirable during this time. Mild stressors have positive effects on neural development and improve the animal's long-term ability to cope with stress (Parker et al., 2004). For example, in rats and squirrel monkeys, exposure to mild or moderate stress early in life can promote resilience to subsequent stressful episodes later in life (Lyons et al., 2010; Ashokan et al., 2016). In dogs, when newborn puppies were exposed to the stimulation of gentle handling and tested later, they were found to be more emotionally stable and exploratory than unstimulated control dogs (Gazzano et al., 2008a).

Despite the beneficial effects of mild stress during this period, there is a point at which stress becomes excessive and detrimental. Longitudinal research in humans shows that aversive and traumatic childhood experiences—or, early-life adversity (ELA)—impair mental and physical health into adulthood (Maccari et al., 2014; Nusslock & Miller, 2016). Studies in humans have identified ELA as a major risk factor for many serious adult mental health problems, such as unstable social relationships and anxiety and depressive mood disorders (Heim & Nemeroff, 2001; Breslau, 2002) as well as psychopathological outcomes, including post-traumatic stress disorder (PTSD), in response to a traumatic event later in life (Brewin et al., 2000; Koenen et al., 2002).

In nonhuman animals, accumulating evidence supports the thesis that ELA has extensive and enduring effects with strong correlations to the development of psychopathology later in life (Sanchez et al., 2001). In fact, the strongest evidence to date suggesting that stressful experiences in early life may cause permanent dysregulation of the HPA axis and multiple long-term behavioral abnormalities comes from animal studies (Ladd et al., 2000; Caldji et al., 2001). Several rodent and primate models of ELA, including those that model maternal separation or loss, abuse, neglect, and social deprivation, have demonstrated that early traumatic experiences are associated with long-term alterations in neuroendocrine responsiveness to stress, emotional and behavioral regulation, coping style, cognitive function, quality of social affiliations and relationships, and expression levels of CNS genes shown to be associated with anxiety and mood disorders (Sanchez et al., 2001; Cohen et al., 2006).

Animal studies focusing on the mechanisms of PTSD have further demonstrated how the long-term effects of ELA parallel those in humans. Rats exposed to trauma as juveniles were more vulnerable to adverse effects of fear conditioning (Cohen et al., 2007), showed decreased basal plasma corticosterone levels that paralleled effects observed in human PTSD patients (Diehl et al., 2007), and exhibited more severe PTSD-like behaviors when stressed in adulthood (Imanaka et al., 2006; Diehl et al., 2007).

Canine studies of the long-term effects of ELA are uncommon. Foyer et al. (2013) found that the environment and experiences during the first weeks of life has long-lasting effects on dogs' behavior in a stressful test situation encountered as adults. In their influential work on behavioral genetics in dogs, Scott and Fuller (1965, p. 118) wrote that the heightened sensitivity to positive environmental influences during the socialization period appears to be similarly sensitive to negative influences. These authors suggest that the sensitivity necessary to facilitate the formation of social relationships also seems to create a heightened vulnerability to permanent psychological trauma (Landsberg et al, 2013, p. 15). Subsequently, Fox and Stelzner (1966) were able to demonstrate a short period at approximately 8 weeks when puppies were hypersensitive to distressing psychological or physical stimuli, and during which a single unpleasant experience could produce long-term aversive or abnormal effects. They concluded that during this brief period of puppyhood, dogs are particularly vulnerable to psychological trauma.

*Socialization period experiences*

Following the neonatal and transition periods, the puppy enters what Scott and Fuller characterized as "the socialization period" (Scott & Fuller, 1965, pp. 89-108). This period—ranging from 3 weeks of age to around 12 weeks of age—is a time during which exposure to stimuli and social experiences has a proportionately greater effect on the formation of neural structures, temperament, and behavior than do events at other times in life (Freedman et al., 1961; Scott & Fuller, 1965, pp. 117-150; Overall, 2013, pp. 123-124; Serpell et al., 2016). During this "sensitive period," healthy psychobehavioral development of puppies requires positive exposure to age-appropriate animate and inanimate stimuli, which prepares the dog for appropriate and flexible responses to those stimuli throughout life (Freedman et al., 1961; Scott & Fuller, 1965, pp. 101-108). Conversely, the consequences of inadequate exposure to varied stimuli include neophobic responses, hyperactivity, impaired social behavior and relationships, decreased exploratory behavior, and diminished learning ability (Melzack & Thompson, 1956; Melzack & Scott, 1957; Freedman et al., 1961; Scott & Fuller, 1965, pp. 101-108; Fuller & Clark, 1966; Fuller, 1967). Puppies with less than adequate early social experience are more likely to exhibit behavioral problems as adults, including aggression (Howell et al., 2015).

Some problem behaviors identified in dogs obtained from pet stores may be attributable to inadequate socialization during puppyhood (e.g., Jagoe, 1994; Mugford, 1995; Bennett & Rohlf, 2007; Serpell et al., 2016), possibly because some may keep dogs in an environment of social isolation during this critical period (O'Farrell, 1986, p. 105). In their study comparing the behaviors of dogs which were still owned by their breeder with behaviors of dogs which were acquired from a breeder and moved to a new home, Casey et al. (2014) found that the former group of dogs was 4.5 times less likely to show aggression to family members than the latter group. The authors suggested that this may be because the more closely the stimuli of the dogs' environment during socialization matched that in which they would live as adults, the more successfully the socialization experiences of these animals would prepare them for their adult environment. Considering that the stimuli in CBEs and pet stores are very dissimilar to that in the typical human home environment, the mismatch of stimuli encountered during the socialization period in these environments and those of adult life may be a major contributor to the behavioral differences observed in CBE-bred dogs. In addition to the broader neophobic responses seen in pet store–obtained dogs, more specific behaviors may also be traceable to inadequate stimulus exposure during the sensitive period. For example, the increased sensitivity to being touched (which includes being petted, picked up, held, and hugged) seen in dogs coming from pet stores (McMillan et al, 2013) and less-responsible breeders (Gray et al., 2016) might be caused by the puppy receiving too little of the normal physical contact with its mother and littermates as well as with humans. Just as for other stimuli to which the young animal is inadequately exposed, we could expect there to be an aversion to physical touch later in life.

The present review shows that aggression is the most prominent finding in studies involving dogs obtained from pet stores or directly from CBEs. In humans, van der Kolk et al (2005) reported that trauma that is prolonged, that first occurs at an early age, and that is of an interpersonal nature, can have significant effects on psychological functioning later in life, including affect dysregulation and aggression against self and others. In addition, the younger the age of onset of the trauma, the more likely one is to exhibit these psychological and behavioral changes.

*Weaning and early maternal separation*

Another critical period in behavioral development is weaning. In nature, weaning of mammalian young is usually a relatively slow process, involving the gradual development of independence of the young from the mother's milk supply and associated maternal care (Scott & Fuller, 1965, p. 101). This stands in contrast with the typical situation in commercial dog breeding, where there occurs an abrupt separation of puppies from their mothers at an age when the young are still suckling frequently and the bond is strong (Newberry & Swanson, 2008). As a stressor, early maternal separation appears to involve at least 3 different processes detrimental to the behavioral development of the young animal and resulting in atypical adult behavior: (1) separation, especially at an age before the natural age of weaning, is itself stressful/traumatic (Slabbert & Rasa, 1993; Panksepp, 1998, p. 166); (2) the stress induced by separation may impair the individual's ability to cope with additional stressors (Slabbert & Rasa, 1993), which is exacerbated when the puppy loses the stress buffering effects of not only its mother but also its littermates and home environment (Newberry & Swanson, 2008); and (3) early separation decreases exposure to stimuli and feedback necessary for the learning associated with the development of acceptable behavior (Overall, 2013, pp. 127-128).

Several studies in different noncanid species (mice, Kikusui et al., 2006; rodents, Kikusui et al., 2004, pigs, Yuan et al., 2004; adult rats, Janus, 1987; Shimozuru et al., 2007; Kikusui et al., 2007; Nakamura et al., 2008; Ito et al., 2006) have demonstrated long-term neurochemical, psychological, and behavioral consequences from early maternal separation, or weaning, where weaning is defined here as a complete severance of the bond between the mother and her offspring, which includes physical separation from the mother, the cessation of suckling, and the cessation of social protection by the mother (Kikusui & Mori, 2009).

Two studies have examined the effects of early maternal separation in dogs. Slabbert and Rosa (1993) compared the physical and psychological developmental effects of early (6 weeks) and late (12 weeks) separation from the mother in dogs, with emphasis on the measurements of temperament and socialization to humans. They found that maternal separation at 6 weeks of age resulted in more distress vocalizations as well as greater weight loss, illness, and mortality in the puppies, which persisted until the age of 6 months. The authors concluded that puppies benefit from prolonged (12 weeks) contact with their mothers and that the common practice among commercial dog breeders of "forced weaning" at a young age results in unacceptable levels of stress for the puppies, the effects of which last well beyond the time of maternal separation. Pierantoni et al. (2011) compared the frequency of behaviors in dogs separated from the litter for adoption at 30-40 days of age and those that had been separated at 60 days. Their findings showed that dogs removed from their litter at the earlier age had a significantly higher frequency of destructive behavior and toy and food possessiveness, were 15 times more likely to exhibit fearfulness on walks, 7 times more likely to show attention-seeking behavior and noise reactivity, and 6 times more likely to bark excessively than dogs that stayed with their mother and littermates until 60 days. Particularly germane to the present discussion, these results were more pronounced if the puppy was obtained from a pet store.

Early separation from the mother and littermates also appears to have consequences for behavior in the adult dog by limiting exposure to stimuli and feedback necessary for the learning associated with the development of acceptable behavior (Overall, 2013, pp. 127-128). When puppies remain with their mother and littermates during the socialization period, their behavioral development is shaped by the learning experiences of observing others' behavior as well as receiving others' feedback in response to their own behaviors (De Meester et al., 2005; Pierantoni et al., 2011). For example, observing the behavior of the mother can passively teach puppies certain skills (Slabbert & Rasa, 1997). In addition, play fighting with their mother and littermates allows puppies to explore and learn the boundaries of acceptable behavior, including bite inhibition (Bekoff, 2001; Bekoff, 2004; De Meester et al., 2005). Much of this learning may be curtailed when puppies are separated from their mother and siblings early in the socialization period, resulting in abnormal behavioral development (De Meester et al., 2005).

The stress of maternal separation is potentially severe by itself but may be compounded when, as in the case of CBE puppies, offspring are abruptly separated from all other familiar stimuli which would otherwise act as a buffer against the stress of maternal separation, as well as against stressors encountered in the days following maternal separation (Newberry & Swanson, 2008). Although studies distinguishing the effects of separation from the mother and the effects of separation from littermates and/or the rearing environment are lacking in dogs, research in other species illustrates this phenomenon (piglets, Puppe et al., 1997; guinea pigs, Pettijohn, 1979; and lambs, Porter et al., 1995).

A final point to keep in mind is that maternal separation even at normal weaning age can affect behavior of the puppy. For example, in the study mentioned earlier by Fox and Stelzner (1966), it was found that traumatic events (e.g., electric shock) experienced by 8- to 9-week-old puppies in the absence of the mother causes long-lasting fear responses. Mogi et al. (2011) commented that these observations have led to the periweaning period of 6-8 weeks after birth now being considered as the peak of the "sensitive period" in dogs and that maternal separation of canine pups around this period may therefore increase the chances of developing behavioral problems in adulthood. This observation may have crucial implications for the common practice among commercial breeders of sending puppies away for sale at around 8 weeks of age.

Various guidelines, regulations, and laws govern the minimum age when puppies may be removed from their mothers to leave the breeding facility. In the United States, the Animal Welfare Act stipulates that puppies, except those sold to research facilities, may not be transported until they are at least 8 weeks of age and have been weaned (Federal Register, 2008). Adherence to these regulations is difficult to confirm, but evidence from other countries shows that puppies are often separated from their mother and littermates much earlier than 8 weeks of age. For example, an investigation by the Daily Mirror (United Kingdom) found that dogs as young as 5 weeks were being purchased from breeders in Hungary for shipment to the United Kingdom for sale (Sommerlad, 2015). De Meester et al. (2005) surveyed 48 Belgian dog breeders and found that the weaning age varied from between 4 and 12 weeks of age.

*Transport and store-related experience*

Puppies born in CBEs face a succession of stressors—those in the CBE environment (as described previously) and then those inherent in the stepwise transition from the breeding facility to the ultimate owner's home (Gaultier et al., 2008, 2009). In particular, transport-related stress has been suggested to be an influential factor in the early lives of puppies from CBEs (Mugford, 1995; Bennett & Rohlf, 2007). Stressors within the pet store environment are further along the continuum of stressors experienced by dogs bred in CBEs. These stressors include multisensory (sight, sounds, smell) exposure to unfamiliar humans including the handling by store employees and prospective buyers, unfamiliar dogs, and animals of other species.

Gaultier et al. (2008, 2009) described how puppies in pet stores may have been subjected to a series of potentially traumatic events,

including repeated rehomings, and inadequate efforts may be made to ease the transition or to minimize any adverse effects (Plujimakers et al., 2006).

Although some dogs arriving in pet stores may be sold quickly and at a comparatively young age, others may be in residence for a more extended period during which stressors can continue to have an adverse, cumulative effect. Serpell and Duffy (2016) evaluated the behaviors of young adult guide dogs, as because of their very structured upbringing, these dogs have well-documented histories regarding stressors and other environmental factors, thus adding credibility to any associations identified between stressors and behavior. Results of their study showed that particular frightening or traumatic events during the puppy-raising period (2-14 months of age) were associated with differences in scores for a number of behaviors. Specifically, puppies that were reported as having been attacked or threatened by another (unfamiliar) dog, when compared to puppies not having this experience, scored significantly higher for fear of dogs and aggression toward unfamiliar humans at 12 months of age. When the trauma involved being frightened by a familiar or unfamiliar person, the dogs exhibited significantly higher levels of fear toward unfamiliar persons and were reported as being less trainable. The authors concluded that puppies and young dogs are sensitive to aversive experiences long after the ostensible end of the socialization period (i.e., 12 weeks) and that such encounters may have long-term negative consequences for behavior. This would also apply to a puppy's experience in the new home after sale.

Canine behavior experts as well as regulatory authorities in various countries either recommend or require that entities rehoming dogs make some attempt to educate owners and/or endeavor to help them select a dog that appears to be suited to their lifestyles (Troughton, 2015; American Kennel Club, 2016; Pirrone et al, 2016). This remains a highly subjective process with no clear standards. However, 2 studies have demonstrated the benefits of educating owners on canine care and behavior. Gazzano et al. (2008b) showed that dogs will exhibit fewer problematic behaviors if the owners receive advice for proper management of their new pet. Herron et al. (2007) found that simply providing a few minutes of preadoption counseling on housetraining improved the success of adoptions of dogs from shelters. To the extent that owner counseling and lifestyle matching is important for the future success of the adoption and well-being of the dog, owners who purchase a puppy from a pet store may be at a disadvantage with respect to understanding normal dog behavior and breed-specific needs, compared to owners who purchase a purebred dog from a noncommercial breeder. The latter is likely to be someone who has raised numerous dogs of that breed to adulthood, whereas an employee in a retail pet store is unlikely to have that degree of knowledge, experience, or the time for follow-up with new owners.

## Limitations

The studies forming the basis of this review had numerous limitations which must be taken into account. First, the data were mostly retrospective or cross-sectional in nature, and thus, the causality of any associations identified remains to be established. Most of the people responding were from various convenience samples of dog owners (e.g., Internet sites, veterinary clinics). Thus, the representativeness of the samples is difficult to ascertain. The sources of dogs were not consistent across all studies, and in some cases, the number of dogs from pet stores was small relative to the number of dogs from other sources. The number and type of behaviors evaluated, as well as the definition of those behaviors, also were not consistent across studies, and the behavioral outcomes summarized relied primarily on owner reports of various behaviors or owner-provided scores on the C-BARQ.

Although the focus of this review was to explain how conditions in CBEs and pet stores could have a causal association with certain types of problematic behaviors in dogs, dogs' experiences in the new home after purchase could also contribute to the perceived frequency and/or severity of certain behavior problems. None of the studies was able to adequately assess or control for confounding due to factors such as owner commitment, or diverse differences in the home environment.

## Summary

Taken as a whole, the data from 7 published studies using surveys of dog owners suggest that dogs sold through pet stores and/or born in high-volume CBEs have an increased frequency of a variety of undesirable adulthood behaviors compared with dogs from other sources, particularly noncommercial breeders. The most common finding (6 of 7 reports, or 86%) was an increase in aggression directed toward the dog's owners and family members, unfamiliar people (strangers), and other dogs. The most consistent type of increased aggression found, as reported in 5 studies (Jagoe, 1994; McMillan et al., 2013; Casey et al., 2014; Gray et al., 2016; Pirrone et al., 2016), was aggression toward owners and family members. The other characteristic found in multiple studies was increased fear (Jagoe, 1994; Pierantoni et al., 2011; McMillan et al., 2013; Gray et al., 2016), which was in response to strangers, children, other dogs, nonsocial stimuli, and being taken on walks. Increased fear of other dogs was reported in 3 of 4 (75%) studies finding increased levels of fear (Jagoe, 1994; McMillan et al., 2013; Gray et al., 2016). Behaviors related to separation and/or attention seeking were reported increased in 3 studies (Pierantoni et al., 2011; McMillan et al., 2013; Gray et al., 2016) and 1 anecdotal report (Mugford, 1995). Heightened sensitivity to touch was reported in 2 studies (McMillan et al., 2013; Gray et al., 2016). Only 1 study examined behaviors based on breed (Gray et al., 2016), and results for those 3 breeds (Chihuahua, pug, Jack Russell terrier) suggested that substantial variation in behaviors among breeds may exist, at least for dogs originating from less responsible breeding operations.

It is important to emphasize that all of the findings thus far reported are correlational in nature, not permitting a determination of causation. Furthermore, because of how dogs sold through pet stores and/or born in CBEs are bred, housed, weaned, transported, handled, and homed, the number of potential causes for the observed behavioral outcomes is large. However, based on even a few of the known stressors inherent in commercial dog breeding practices (e.g., prenatal maternal stress, ELA, and poor socialization), a plausible argument consistent with known behavior theory can be made to explain why dogs raised in these environments may have an increased frequency of certain behavior problems.

Despite the fact that pinpointing specific causes is not possible due to the high number of stress-related factors potentially contributing to behavioral development, it is clear that one crucial corrective measure is for stressors to be substantially reduced at all stages of the puppy's development. Reduction of stressors that contribute to long-lasting behavioral and emotional distress should begin at the prenatal stage and extend throughout adolescence. Measures to reduce such stress include provisioning of housing conducive to a good quality of life for the adult breeding dogs as well as the puppies, and gradual weaning of the puppies. A high-quality social and stimulus exposure program should be instituted for puppies beginning no later than 3 weeks of age and continue through the end of the socialization period—during which the puppy will pass through the hands of the breeder, the pet store staff, and the new owner—at 12-16 weeks. To reduce maternal

contributions to problematic behavioral development, dams should also be exposed to such programs. High-quality, life-stage nutrition will facilitate the contribution of these measures to neurodevelopment. These measures are essential to avoid the development of problem behaviors in adult dogs.

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## Ethical considerations

No approval was required for this work.

## Conflict of interest

The author declares that no conflict of interest exists in which the author or author's organization has a financial, personal, or other relationship with other people or organizations that could inappropriately influence, or be perceived to influence, the author's work.

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# Differences in behavioral characteristics between dogs obtained as puppies from pet stores and those obtained from noncommercial breeders

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**Objective**—To compare the owner-reported prevalence of behavioral characteristics in dogs obtained as puppies from pet stores with that of dogs obtained as puppies from noncommercial breeders.

**Design**—Cross-sectional study.

**Animals**—Dogs obtained as puppies from pet stores (n = 413) and breeder-obtained dogs (5,657).

**Procedures**—Behavioral evaluations were obtained from a large convenience sample of current dog owners with the online version of the Canine Behavioral Assessment and Research Questionnaire, which uses ordinal scales to rate either the intensity or frequency of the dogs' behavior. Hierarchic linear and logistic regression models were used to analyze the effects of source of acquisition on behavioral outcomes when various confounding and intervening variables were controlled for.

**Results**—Pet store–derived dogs received significantly less favorable scores than did breeder-obtained dogs on 12 of 14 of the behavioral variables measured; pet store dogs did not score more favorably than breeder dogs in any behavioral category. Compared with dogs obtained as puppies from noncommercial breeders, dogs obtained as puppies from pet stores had significantly greater aggression toward human family members, unfamiliar people, and other dogs; greater fear of other dogs and nonsocial stimuli; and greater separation-related problems and house soiling.

**Conclusions and Clinical Relevance**—Obtaining dogs from pet stores versus noncommercial breeders represented a significant risk factor for the development of a wide range of undesirable behavioral characteristics. Until the causes of the unfavorable differences detected in this group of dogs can be specifically identified and remedied, the authors cannot recommend that puppies be obtained from pet stores. (*J Am Vet Med Assoc* 2013;242:1359–1363)

It has long been an article of faith among veterinarians and canine professionals that dogs obtained as puppies from pet stores have a higher prevalence of health and behavioral problems.[1] However, there has been a dearth of empirical studies to support this notion. In a retrospective survey of the owners of 737 adult dogs, Jagoe[a] found that dogs obtained from pet shops had a significantly higher prevalence of owner-directed (dominance-type) aggression and social fears (fear of strangers, children, and unfamiliar dogs) than did dogs from 5 other sources: breeders, animal shelters, friends or relatives, found or rescued off the streets, and home bred (ie, bred and reared in the current owner's home).[2] However, the sample size of pet store dogs in that study[a] was small (n = 20).

Bennett and Rohlf[3] investigated the frequency of potential problematic behavior patterns as reported by owners in a convenience sample of 413 companion dogs, of which 47 were obtained from pet stores. Results indicated that dogs purchased from pet shops or shelters were considered by their owners to be more unfriendly or aggressive than were dogs purchased from breeders and significantly more nervous than dogs bred by the present owner. However, by using broadly defined behavioral subscales rather than discrete behaviors, the researchers were not able to ascertain whether pet shop dogs had specific problematic behaviors more frequently than did dogs from other sources.

Mugford[4] reported analyzing a sample of 1,864 dogs with various behavioral problems and determined that "only 10% of purebred dogs obtained directly from breeders presented separation-related problems, whereas 55% of purebred dogs originating from so-called 'puppy farms' or 'puppy mills' present such problems." Sample sizes and the way in which it was determined

**Abbreviations**

| | |
|---|---|
| C-BARQ | Canine Behavioral Assessment and Research Questionnaire |
| CBE | Commercial breeding establishment |
| NCB | Noncommercial breeder |

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that the dogs came from puppy farms or puppy mills were not reported.

Some inconsistent findings have also been reported. Pierantoni et al[5] compared owner-reported behaviors between 70 adult dogs separated from their litters at 30 to 40 days of age and 70 adult dogs separated from their litters at 2 months of age. Their analysis included the source of the dog classified into 3 categories: breeder, pet shop, or friend or relative. The researchers found no significant association between the source of the dog and the behavioral categories examined. In a study of the efficacy of a dog-appeasing pheromone in reducing stress associated with social isolation in puppies recently acquired from pet stores, Gaultier et al[6] noted that their data did not seem to support the hypothesis that puppies from pet stores constitute a special, at-risk population for the development of behavioral problems. The researchers reported that the puppies in that study[6] (n = 66) did not appear to disturb their owners any more than those in a previous study by Taylor and Mills[7] involving puppies acquired from local pedigree dog breeders. However, the breeders in the latter study[7] included a semicommercial breeder and at least 1 puppy mill.[b]

Most puppies sold by pet stores in the United States are purchased from brokers, who may themselves be breeders but overwhelmingly acquire their puppies from high-volume breeding facilities, or CBEs, located throughout the United States.[8] Conditions in the CBEs, which supply tens of thousands of puppies to retail pet stores each year, vary widely. Conditions in CBEs range from modern, clean, and well-kept to squalid, noxious, and gravely detrimental to animal health and welfare.[9–11]

The purpose of the study reported here was to evaluate the hypothesis that dogs obtained as puppies from pet stores would be reported to have an increased prevalence of behavioral problems, compared with dogs obtained as puppies from NCBs.

## Materials and Methods

**Data collection**—Behavioral evaluations of the dogs were obtained by use of the online version of the C-BARQ, a standardized survey instrument with established reliability and validity characteristics.[12] The C-BARQ is designed to provide quantitative assessments of a wide array of behavioral characteristics of dogs and has been widely used as a research tool for comparing behavior in different dog populations.[13–15] The questionnaire consists of 100 items that ask respondents to indicate on a series of 5-point ordinal rating scales their dogs' typical responses to a variety of everyday situations during the recent past. The scales rate either the intensity (aggression, fear, and excitability subscales) or frequency (all remaining subscales and miscellaneous items) of the behaviors, with a score of 0 indicating the absence of the behavior and a score of 4 indicating the most intense or frequent form of the behavior. The C-BARQ currently comprises 14 behavioral factors or subscales and a further 22 miscellaneous stand-alone items. Higher scores are generally less favorable for all items and subscales, with the exception of trainability, for which higher scores are more desirable. Owners were also asked to indicate the dog's current age at the time the survey was completed, whether there were other dogs living in the same household, and whether the dog was used for specific working or recreational roles, including breeding or showing, field trials or hunting, other sports (eg, agility, racing, or sledding), and working roles (eg, search and rescue, service, or sheep herding). To obtain information on the source from which the dog was acquired, owners were also asked to respond to the question, "where did you acquire this dog?" Possible responses included the following: bred him/her myself; from a breeder; from a shelter or rescue group; from a neighbor, friend, or relative; bought from a pet store; adopted as a stray; and other. Consistent with the 2 previous studies[3,a] that offered pet-owning participants the choice of breeder as the source of the dog, the question in the C-BARQ regarding the source of the dog does not define the term breeder.

**Sample**—The online C-BARQ was advertised originally via an article in the newsmagazine of the Veterinary Hospital of the University of Pennsylvania and by notices sent to Philadelphia-area veterinary clinics and the top 20 US breed clubs, as determined on the basis of American Kennel Club registrations. Availability of the survey then spread via word of mouth. No geographic limitations were applied, and participation included residents of the United States as well as other countries. A subset of these data consisting entirely of pet dogs whose owners reported obtaining them either from breeders (n = 5,657) or pet stores (413) was used for analysis. Breeder-obtained dogs were selected as the comparison group for the following reasons: age at the time of acquisition would most closely match pet store–obtained dogs; for the most part, breeder-obtained dogs are purebred as are those from pet stores; and the life history of the dog prior to purchase in breeder-obtained puppies is relatively standardized, thereby reducing the amount of environmental variability among the dogs of this group. These assumptions apply to the United States and may have less validity in other countries.

**Statistical analysis**—Two-level hierarchic linear or logistic regression models were used to analyze the data on behavioral measures.[16] The outcome variables (attachment and attention seeking, chasing, trainability, excitability, and energy) in the hierarchic linear model were treated as normally distributed continuous variables. All other behavioral variables were dichotomized (eg, 0 or > 0) because they were typically highly skewed and it was impossible to identify a suitable transformation method to normalize their distribution. These were analyzed with 2-level mixed logistic models. Both types of model aimed to assess the relationship between source of acquisition (eg, pet store vs breeder) and behavior while controlling for various confounding variables (other dogs in household, working or recreational roles, sex, and body weight) or intervening variables (neutered vs sexually intact and age at the time of evaluation). All possible 2-way interactions between source of acquisition and confounding and intervening variables were explored and accounted for in the modeling process. Nonsignificant confounding and intervening variables and interaction effects were removed from the

model. Breed was also included in both models as a random effect to account for clustering of dogs at the breed level. Linear and logistic models were fit via restricted and full maximum likelihood estimation procedures. The analysis was performed with statistical software[17] by use of subject-specific models.[c,d] For all comparisons, a value of $P < 0.05$ was considered significant.

## Results

According to the results of the multiple regression analyses, dogs acquired from pet stores differed significantly from those acquired from breeders on 12 of 14 of the C-BARQ behavioral subscales. In no category did pet store dogs have a more desirable score than breeder dogs (**Tables 1 and 2**). The strongest effects were observed in relation to aggressive behavior. For example, sexually intact pet store dogs were 3 times as likely to have owner-directed aggression as were sexually intact dogs acquired from breeders, and pet store dogs were nearly twice as likely to have aggression toward unfamiliar dogs (dog-directed aggression). Pet store dogs were also 30% to 60% more likely to have stranger-directed aggression, aggression to other household dogs, fear of dogs and nonsocial stimuli, separation-related problems, and touch sensitivity. In addition, they were somewhat more excitable, energetic, and attention seeking and generally less trainable, although this was only true for dogs that did not participate in working or recreational activities. The only C-BARQ subscales that were not significantly different between pet store and breeder-derived dogs were chasing and stranger-directed fear. In addition, pet store–obtained dogs had a range of miscellaneous behavioral problems at significantly higher frequencies than did those acquired from breeders (eg, escaping from the home, sexual mounting of people and objects, and most forms of house-soiling).

## Discussion

Results of this study supported the view that dogs obtained as puppies from pet stores are more likely to develop behavioral problems as adults, compared with dogs obtained from NCBs. The retrospective nature of the data used in this analysis did not permit determinations of causality. However, there are several potential explanations for the differences between pet store and NCB dogs.

Table 1—Results of linear regression models comparing behavioral variables in dogs obtained from pet stores versus dogs obtained from NCBs.

| Variable | Other variables controlled | Predictor | Effect | 95% CI | *P* value |
|---|---|---|---|---|---|
| Excitability | 1,2,3,4,6 | PS | 0.204 | 0.12 to 0.29 | < 0.001 |
| Energy | 1,2,3,4,6 | PS | 0.109 | 0.004 to 0.21 | 0.043 |
| Chasing | | PS | 0.002 | –0.13 to 0.10 | 0.769 |
| Attachment and attention seeking | 1,2,3,4,5,6 | PS | 0.204 | 0.12 to 0.29 | < 0.001 |
| Trainability | 1,2,3,4,5,6 | PS–Not working dog | –0.195 | –0.26 to –0.13 | < 0.001 |
| | | PS– Working dog | 0.098 | –0.07 to 0.27 | 0.262 |

PS = Acquired from pet store.
Other variables controlled were as follows: 1 = other dogs, 2 = dogs with working or recreational roles, 3 = sex, 4 = weight, 5 = neutered, 6 = age at time of evaluation (nonsignificant intervening variables [those variables that intervene the relationship between variable and predictor] were removed from the analyses).

Table 2—Results of logistic regression models comparing behavioral variables in dogs obtained from pet stores versus dogs obtained from NCBs.

| Variable | Other variables controlled | Predictor | OR | 95% CI | *P* value |
|---|---|---|---|---|---|
| Separation-related behavior | 1,2,3,4,5,6 | PS | 1.58 | 1.19–2.11 | 0.002 |
| Owner-directed aggression | 1,2,3,4,5,6 | PS–Not neutered | 3.13 | 1.87–5.23 | < 0.001 |
| | 1,2,3,4,5,6 | PS–Neutered | 1.54 | 1.16–2.06 | 0.003 |
| Stranger-directed aggression | 1,2,3,4,5,6 | PS | 1.59 | 1.18–2.16 | 0.003 |
| Nonsocial fear | 1,2,3,4,5 | PS | 1.44 | 1.01–2.07 | 0.047 |
| Dog rivalry | 1,2,3,4,6 | PS | 1.35 | 1.05–1.74 | 0.021 |
| Dog-directed fear | 1,2,3,4,5 | PS | 1.33 | 1.03–1.71 | 0.030 |
| Dog-directed aggression | 1,2,3,4,5,6 | PS | 1.96 | 1.44–2.67 | < 0.001 |
| Touch sensitivity | 1,2,3,4,5,6 | PS | 1.58 | 1.18–2.11 | 0.002 |
| Escapes from home or yard | 1,2,3,4,5,6 | PS | 4.14 | 1.75–9.83 | 0.001 |
| Rolls in odorous material | | PS | 0.86 | 0.67–1.09 | 0.214 |
| Coprophagia | | | 1.08 | 0.86–1.36 | 0.502 |
| Chews objects | | | 1.07 | 0.84–1.36 | 0.590 |
| Mounts objects or people | 1,2,3,4,5 | | 1.39 | 1.1–1.75 | 0.006 |
| Urinates against objects or furnishings | 1,2,3,4,5,6 | PS | 1.77 | 1.32–2.39 | < 0.001 |
| Submissive urination | 1,2,3,4,5,6 | PS | 1.53 | 1.13–2.07 | 0.007 |
| Urinates when left alone | 1,2,3,4,5,6 | PS | 1.96 | 1.52–1.52 | < 0.001 |
| Defecates when left alone | 1,2,3,4,5 | PS | 1.68 | 1.31–2.16 | < 0.001 |

*See* Table 1 for key.

The formative stages of the puppy's life in the CBE are periods where stress may exert an impact on brain development. Although no studies on sources of stress in CBEs or their potential effects on the well-being of the dogs have been published, sources of stress have been investigated in dogs living in confinement in kennels,[18–21] animal shelters,[22,23] and laboratories.[24,25] Similar stressors have been documented in the CBE environment,[10] and it is therefore reasonable to suggest that the effects applied also to the dogs in the present study, despite some differences in background, housing, and husbandry. Specific factors that have been determined to be associated with stress in dogs living in confined environments include spatial restriction,[18,19,23] extreme temperatures,[9,26] aversive interactions with kennel staff,[26,27] lack of perceived control or the capacity to avoid or regulate exposure to aversive stimuli,[20–23] and limited access to positive human and conspecific social interactions.[18,24,25] A recent study[11] on the mental health of dogs formerly used as breeding stock in CBEs found severe and long-lasting adverse effects in dogs living in this type of environment, offering evidence of the magnitude of stressors in CBEs.

The stressors in the CBE environment may have acted at 2 stages of the developing puppies' lives: the prenatal period and the first 8 weeks after birth. A large body of research in humans and other animals has convincingly determined that prenatal stress (ie, stress experienced by a pregnant female) causes alterations to the hypothalamic-pituitary-adrenal axis of the developing fetus that may manifest later in life as an impaired ability to cope with stress,[22] abnormal social behavior,[28,29] and increased emotionality and fear-related behavior.[30] All of these outcomes are consistent with the differences detected in pet store– versus NCB-obtained dogs (ie, increased aggression, fear of dogs and nonsocial stimuli, and excitability). Substantial evidence in humans and other animals indicates that stressful experiences in early life may have extensive and enduring effects with strong correlations to later development of behavioral abnormalities and psychopathologic abnormalities.[31–35] In dogs, Fox and Stelzner[36] detected a short period at approximately 8 weeks of age when puppies are hypersensitive to distressing psychological or physical stimuli and during which a single unpleasant experience could result in long-term aversive or abnormal effects. Transport-related stress was suggested by both Mugford[4] and Gaultier et al[6] to be a potentially critical factor in the early lives of puppies from CBEs as they are shipped to pet stores throughout North America. Mugford,[4] Serpell and Jagoe,[2] and Bennett and Rohlf[3] have each suggested that a reason for pet store and CBE puppies to have a high prevalence of behavioral problems later in life is inadequate early socialization. In addition, genetic influences may play a role in the differences between pet store and NCB dogs, because a genetic basis for behavioral traits in dogs is consistent with findings observed in dogs of the present study, including fear, aggression, emotional reactivity, and nonspecific alterations in temperament and personality.[27,37,38]

The reported differences in the 2 groups of dogs in the present study could be attributable to a number of owner-related factors. It is possible that people who buy puppies from pet shops may use different degrees or methods of training than people who buy puppies from an NCB. The importance of training in the development of problem behaviors was recently elucidated in the study[3] of the relationship of potentially problematic behaviors with other variables. The researchers found that for the 5 behavioral subscales, the strongest predictor for scoring undesirably in 3 of the 5 subscales was the level of training the dog received. The present study did not attempt to collect demographic or background information on the dog owners; therefore, the degree to which such factors may have contributed to the findings could not be assessed. An additional owner-related consideration is that it is possible that people who buy puppies from pet stores simply report potentially problematic behaviors more readily than do others, irrespective of the dog's actual behavior.

The data support the notion that dogs obtained as puppies from pet stores have substantial adverse behavioral differences, compared with dogs obtained from NCBs. Taken individually, however, the specific factors that differ between the 2 groups are not readily attributable to a single definitive explanation. For example, stranger-directed aggression may be attributable to inadequate socialization, maltreatment by humans, genetic factors, and prenatal stress. Taken collectively, no single explanatory factor appears capable of accounting for the differences between the 2 groups. For example, although inadequate socialization may explain increased aggression, the most prominent emotional consequence of insufficient socialization is fear,[27,39] and whereas aggression toward humans (owners and unfamiliar people) was increased, fear toward humans was not.

There were a number of limitations to the present study. The sample of dog owners was self-selected and therefore a potential source of bias. The question in the C-BARQ regarding the source of the dogs did not define breeder, leaving the participants to define the term for themselves. Accordingly, a breeder source could have indicated either type of NCB (hobby breeder or backyard breeder), and the level and type of care differ between the 2 types. These differences are presumably minor in comparison to the differences between NCBs and CBEs. It is also conceivable that the source of some dogs specified by the owner as breeder was a CBE; however, it is reasonable to conclude that there would be no overlap between breeder and pet store categories (ie, no owner with a dog coming from a pet store would select breeder as a source, and no owner with a dog coming from a breeder would select pet store as a source).

Results of the present study indicated that compared with dogs obtained as puppies from NCBs, dogs obtained as puppies from pet stores had significantly greater aggression toward human family members, unfamiliar people, and other dogs; fear of other dogs and nonsocial stimuli; separation-related problems; and urination and defecation problems in the home. On almost all behavioral variables measured, pet store dogs received less favorable scores than breeder-obtained dogs. The diversity of behavioral differences between pet store–obtained and breeder-obtained dogs suggests a multifactorial cause and, accordingly, a multifactorial approach to correction; however, the data did not permit determination of the specific contributory factors and the degree of influence they exerted. In addition,

because we did not compare the 2 groups of dogs in this study with other sources of dogs, the results should not be interpreted as an endorsement of any particular source of dogs. On the basis of these findings combined with earlier findings regarding pet store–obtained dogs, until the causes of the unfavorable differences detected in this group of dogs can be specifically identified and remedied, we cannot recommend that puppies be obtained from pet stores.

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