



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.

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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 appearance 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 over-represented 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 <i>P</i> -values for Pearson chi-square: "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%); <i>P</i> = 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 Unfriendly/aggressive (PS, 8.70, <i>P</i> < 0.01; BR, 5.61; AS, 7.83 <i>P</i> < 0.01); F/R, 7.75; HB, 8.20; ST, 5.84) (reference category is BR for <i>P</i> -values) Nervous (PS, 7.50, <i>P</i> < 0.05; BR, 5.49; AS, 6.18; F/R, 5.02; HB, 4.80; ST, 5.58) (reference category is SB for <i>P</i> -values) Excitable (PS, 3.81, <i>P</i> < 0.05; BR, 3.28, <i>P</i> < 0.05; AS, 3.58, <i>P</i> < 0.05; F/R, 3.64, <i>P</i> < 0.05; HB, 2.00; ST, 2.47, <i>P</i> < 0.05) (reference category is SB for <i>P</i> -values) Disobedience (NS across sources) Anxious/destructive (NS across sources) 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 F/R, n = 47 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 Destructiveness: 80% versus 20%, <i>P</i> = 0.017 Excessive barking: 78% versus 22%, <i>P</i> = 0.007 Toy possessiveness: 100% versus 0%, <i>P</i> = 0.000 Fearfulness on walks: 91% versus 9%, <i>P</i> = 0.001 Attention seeking: 71% versus 29%, <i>P</i> = 0.002 Aversion to strangers: 80% versus 20%, <i>P</i> = 0.005 Play biting: 87% versus 13%, <i>P</i> = 0.032 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	<p>Data are OR [95% CI] for dogs from PS versus BR</p> <p>Owner-directed aggression (intact dogs): 3.13 [1.87; 5.23], $P < 0.001$</p> <p>Owner-directed aggression (neutered dogs): 1.54 [1.16; 2.06], $P = 0.003$</p> <p>Dog-directed aggression: 1.96 [1.44; 2.67], $P < 0.001$</p> <p>Stranger-directed aggression: 1.59 [1.18; 2.16], $P = 0.003$</p> <p>Dog rivalry: 1.35 [1.05; 1.74], $P = 0.021$</p> <p>Dog-directed fear: 1.33 [1.03; 1.71], $P = 0.030$</p> <p>Nonsocial fear: 1.44 [1.01; 2.07], $P = 0.047$</p> <p>Separation-related behavior: 1.58 [1.19; 2.11], $P = 0.002$</p> <p>Touch sensitivity: 1.58 [1.18; 2.11], $P = 0.002$</p> <p>Escape behavior: 4.14 [1.75; 9.83]; $P = 0.001$</p>	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	<p>Data are adjusted OR [95% CI] for aggression toward members of the family or household versus dogs from breeders as the reference category</p> <p>AS, 2.638 [1.590; 4.376]</p> <p>HB, 0.224 [0.054; 0.934]</p> <p>F/R, 0.555 [0.132; 2.332]</p> <p>Other (incl PS) 1.786 [1.067; 3.299]</p>	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	<p>Data are frequency of owner-assessed problem behaviors for dogs from pet stores versus official breeders, respectively.</p> <p>Separation-related behavior: 30% versus 17%, $P = 0.023$; OR [95% CI]: 1.997 [1.29; 3.532]</p> <p>House soiling: 15% versus 5%, $P = 0.0004$; OR 3.081 [1.398; 6.974]</p> <p>Body licking: 30% versus 14%, $P = 0.001$; OR 5.580 [1.440; 4.620]</p> <p>Owner-directed aggression: 21% versus 10%, $P = 0.009$; OR 2.396 [1.227; 4.678]</p> <p>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</p>	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. 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, $P < 0.05$). 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, $P < 0.05$). 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)
Not assessed in study A; elevated but with confounder in study B	Most forms of house soiling ↑	↔ (after correction for confounders)
Elevated in study A; not elevated 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 ↔
Elevated in study A; not assessed in study B	Attention-seeking behavior ↑	Attention-seeking behavior ↔
	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

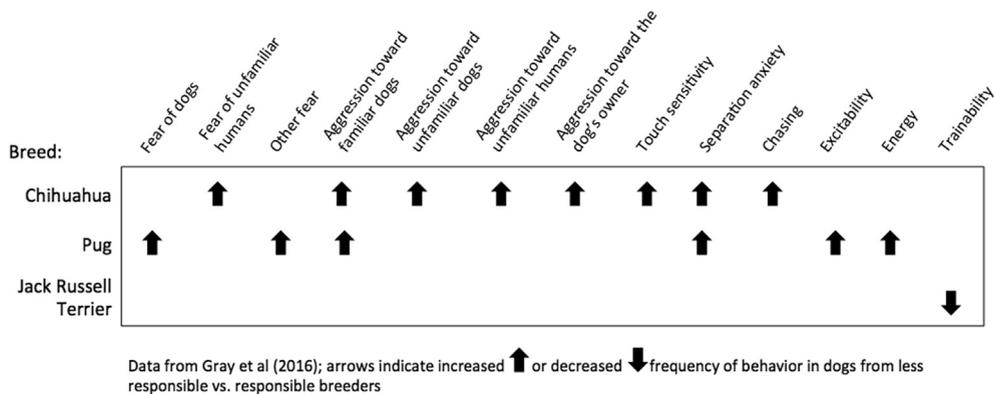


Figure 1. Relative frequency of behavior problems in dogs from less-responsible breeders compared with dogs from responsible breeders for 3 breeds of dogs.

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

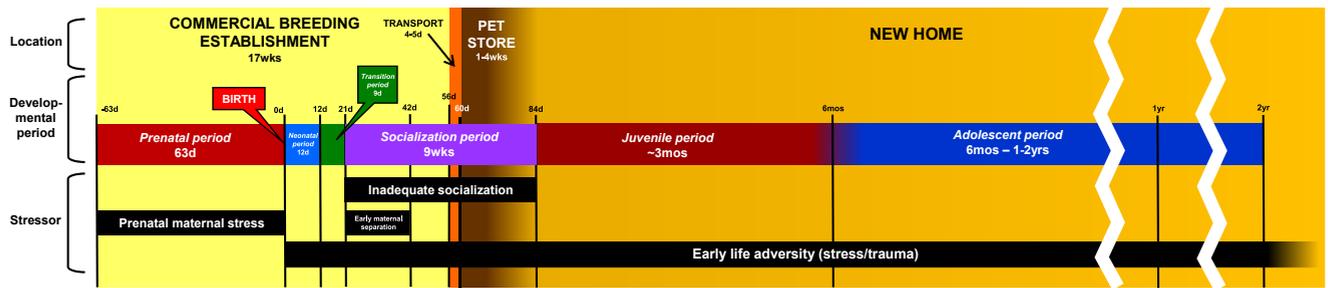


Figure 2. Chronology of developmental periods, living environment, and stressors in the United States. The age at which the puppies leave the breeding facility is often considerably earlier in other countries (and may also be earlier in the United States if there is not strict adherence to applicable 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 rehoming, and inadequate efforts may be made to ease the transition or to minimize any adverse effects (Plujmakers 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 neuro-development. 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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