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Former laboratory dogs' psychological and behavioural characteristics

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Abstract: It is becoming increasingly common for laboratories to allow the rehoming of dogs when they are no longer needed. There is no research, however, comparing the characteristics of dogs from laboratories to dogs acquired from more traditional sources for pets. This study used the Canine Behavioral Assessment and Research Questionnaire (C-BARQ) to compare emotional and behavioural characteristics of 100 former laboratory Beagles who were rehomed to a convenience sample of 244 pet Beagles with no known history of laboratory use. Our results revealed that the former laboratory Beagles exhibited increased fearfulness, attention and attachment behaviours, and more abnormal behaviours than the convenience sample, yet were significantly less aggressive, and likely to chase other animals or escape. Importantly, we also found no significant differences in a majority of the everyday behaviours assessed. Our findings demonstrate dogs rehomed from laboratories form strong bonds with their caregivers, and make equally good companions as their non-laboratory counterparts. Our findings may be helpful in designing appropriate rehabilitation programmes, educating laboratory workers and potential adopters, and support the ongoing efforts to offer these dogs for adoption.

Keywords: adoption; behaviour; canine; distress

In 2019, there were more than 64 500 dogs in United States (US) laboratories (United States Department of Agriculture 2019) and nearly 18 000 dogs in European Union (EU) laboratories (European Commission 2018) (these are the last years that the data were available in both the US and EU). Beagles are the preferred species of dogs in laboratories due to their small size and docile nature (Hanninen and Norring 2020; US Department of Health and Human Services 2004). Dogs used in research are often euthanised for histology or die due to the nature of the experiment itself, for example, in toxicity testing (Carbone et al. 2003). However, there are some US states that have passed laws requiring research facilities to offer dogs for adoption at the end of non-terminal protocols, and some laboratories voluntarily do so (Doring et al. 2017a; Doring et al. 2017b; Skidmore and Roe 2020). In Europe, the Laboratory Animal Science Association (LASA 2004) has developed guidelines for the rehoming of dogs. EU Directive 2010/63 also gives European institutions the opportunity to offer dogs for adoption when no longer needed for research if their welfare would not be compromised (Hanninen and Norring 2020; The European Parliament and The Council 2010).

Dogs in laboratories are used for a variety of purposes, most commonly disease research, toxicity testing for regulatory purposes, and basic research (European Commission 2018). These dogs may also experience a variety of negative housing conditions. This might include excessive noise from other dogs barking, bright lighting, small enclosures, not being properly socialised or given adequate exercise, which can result in persistent stress and the displaying of abnormal behaviours (Beerda et al. 1999; Beerda et al. 2000; Scullion Hall et al. 2017).

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While there is extensive research on chronic stress in dogs in laboratories, there is little research assessing their emotional state after rehoming from the laboratories (Ake 1996).

Two recent studies, using behavioural tests, observations, and caregiver interviews, examined the behaviour of Beagles from a laboratory. They found the dogs exhibited fearful behaviours, and had attachment problems up to three months after adoption (Doring et al. 2017a; Doring et al. 2017b). Another recent study (Hanninen and Norring 2020) also found residual fear of new people, surroundings, and dogs, four years after being rehomed. Importantly, however, they found that the dogs exhibited more desirable behaviours as more time passed (Doring et al. 2017b), that the majority of individuals adopting them said they would do it again in the future (Doring et al. 2017b), and that all new owners "overwhelmingly adored their new dogs and praised their good nature" (Hanninen and Norring 2020, p. 120). This demonstrates that their caregivers do not perceive any residual behaviours associated with increased fear as problematic.

Given the increasing number of dogs being adopted out of laboratories in the US and EU, we were interested in conducting a large-scale assessment of their emotional and behavioural characteristics after rehoming in comparison to dogs who had no known history of laboratory use. Based upon previous research on dogs in laboratories (Hetts et al. 1992; Beerda et al. 1999; Beerda et al. 2000; Araujo et al. 2013), the behavioural assessment of Beagles rehomed from laboratories (Doring et al. 2017a; Doring et al. 2017b; Hanninen and Norring 2020), and dogs who experienced negative early-life experiences in domestic settings (McMillan et al. 2015), we hypothesised that the Beagles from laboratories would exhibit increased levels of fear, would engage in more abnormal behaviours, and have increased attachment issues relative to the convenience sample. We also hypothesised, however, that they would exhibit many typical dog behaviours, and an increased attachment to their caregivers, indicating they can successfully adjust to life in private homes.

MATERIAL AND METHODS

We obtained our data via two different methods. The Beagle Freedom Project (BFP), a US based organisation that rehomes animals released from US laboratories, helped recruit participants that had adopted Beagles through their organisation. BFP posted the participation solicitation in a private BFP adopters Facebook group comprised of 612 individuals living in the US, all of whom adopted dogs through their organisation. They also sent the invitation via email to the same group of individuals. The solicitation for participants indicated that the study's aim was to understand how their dogs readjusted to life after living in a laboratory by assessing their emotional and behavioural characteristics via an online survey. The criteria for participation included that the dog must a) be a Beagle, b) have been rescued from a laboratory, and, c) be living in their home for more than six months. This was to account for an adjustment period for the dogs adapting to life outside of the laboratory, and to ensure that the caregivers had a basic familiarity with their dogs' behavioural patterns and temperament before completing the survey. To our knowledge, no formal training is provided to the adoptive caregivers, but they are screened by the BFP.

The data on the Beagles for our comparison sample of dogs, hereafter referred to as the convenience sample, were obtained from the University of Pennsylvania's Canine Behavioral Assessment and Research Questionnaire (C-BARQ) database (Hsu and Serpell 2003). The criteria for the data inclusion entailed that the dog a) must be a Beagle and b) have lived in an individual's home for more than six months before completing the C-BARQ.

Since we did not interact with any dogs directly, there was no animal ethics review. Instead, Marymount University's Institutional Review Board approved all the procedures.

Behavioural and emotional assessment

The C-BARQ is an online questionnaire used by caregivers, handlers, and professionals to assess the behaviour in dogs (www.cbarq.org). It is comprised of 101 items assessing the dogs' typical responses to a variety of everyday situations. Responses are indicated on a 5-point ordinal scale, with 0 indicating that a behaviour is absent, and 4 indicating the most intense or frequent form of a behaviour (Hsu and Serpell 2003). Caregivers are asked to provide answers about the dog's behaviour at the time of evaluation, and in the recent past.

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The C-BARQ yields scores for 14 categories of behaviour, with scores calculated from up to 10 ratings, and on 22 miscellaneous behaviours from individual questions [see electronic supplementary material (ESM)]. There are also opportunities for the caregivers to provide open-ended comments after some of the questions. For all 14 categories and 22 individual behaviours assessed, lower scores indicate more desirable behaviours, except for trainability, where higher scores are more desirable. If the participants did not answer 25% or more of the questions relating to a specific subscale score, or did not answer a question relating to miscellaneous behaviours, that subscale or behavioural score was recorded as a missing value.

Participant and animal information

Ninety-one individuals, caring for 100 former laboratory Beagles, completed the C-BARQ survey for their dogs. Caregivers were also asked questions about the dogs' sex, age at acquisition, and age at time of evaluation. The laboratories do not release the experimental protocols or veterinary records when the dogs are adopted out.

In the rare case where these records are released with the dogs, the BFP must sign non-disclosure agreements, and are not allowed to share that information with their caregivers (Lopresti-Goodman 2016). Therefore, we have no information about their life in the laboratory facility, the procedures they were used in, their housing conditions, or whether they received any socialisation or behavioural training prior to being rehomed from the laboratories.

The scores from the former laboratory Beagles were compared to the ratings for the convenience sample of Beagles from the C-BARQ database. The convenience sample dogs were selected based upon the breed (e.g., Beagles) and must have lived in their homes at time of evaluation for six months or longer. These criteria yielded a convenience group sample size of 244 Beagles who came from a variety of sources, including breeders or pet stores (n = 88), friends or relatives (n = 23), shelters or strays (n = 106), or "other" sources (n = 27). It must be acknowledged, that we are also unaware of the conditions the convenience sample of dogs lived in, and that some in the "other" source category may have come from laboratories.

Statistical analyses

To determine whether the two groups of Beagles differed in their composition of males and females, a chi-square test for the goodness of fit was run. Independent sample t-tests were used to assess the differences regarding the age at which they were evaluated and acquired.

Given that missing values would not be counted in a multivariate analysis of variance (MANOVA), scores from the 14 C-BARQ categories and 22 individual behaviours were analysed using multiple one-way analyses of variances (ANOVAs), with Ns separately determined for each subscale and behaviour assessed. Statistical significance levels were adjusted via Bonferroni corrections with an alpha set at $P < 0.001$ 4. The data for certain categories and behaviours were not normally distributed, therefore, these items were rank ordered, and the ANOVAs were rerun. There were no differences in the pattern of the results between the original and the rank ordered data, therefore, the data in their original format were used.

RESULTS

A chi-square test revealed the two groups did not differ regarding the number of males and females (former laboratory Beagles: n = 58 males, n = 42 females; convenience sample: n = 137 males, n = 107 females), χ^2 (1, N = 344) = –0.28, P = 0.75.

An independent sample t-test revealed no difference between the former laboratory dogs' age at the time of evaluation (median = 5.00, mean = 5.66, SD = 2.97 years old) and the convenience sample dogs' age at the time of evaluation (median = 5.00, mean = 5.73, SD = 3.30 years old), t(342) = 0.83, P = 0.78. There was a significant difference between their ages at time of acquisition, however, with the former laboratory Beagles (median = 2.77, mean = 3.30, SD = 2.58 years old) being significantly older than the convenience sample age at time of acquisition (median = 0.48, mean = 1.49, SD = 2.03 years old), t(159.31) = 6.65 (this t-score reflects equal variances were not assumed), $P < 0.001$.

The results from the 36 ANOVAs revealed significant differences on 7 of the 14 categories of behaviour (50%) and 4 of the 22 individual behaviours (19%) assessed [all $P < 0.001$ 4; see Table 1 where the number of responses (N) for each category or be-

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Table 1. Results of the ANOVAs comparing the former laboratory and convenience samples

C-BARQ categories or individual behaviours[a]		Beagle sample			
		former laboratory	convenience		
	N[b]	M (SE)	M (SE)	F	η^2
Trainability	244	2.15 (0.05)	2.17 (0.03)	< 1.00	0.00
Stranger-directed aggression	**344**	**0.23 (0.04)**	**0.53 (0.04)**	**6.32**	**0.04**
Owner-directed aggression	344	0.18 (0.04)	0.33 (0.04)	5.20	0.02
Dog-directed aggression	**342**	**0.44 (0.07)**	**0.96 (0.06)**	**21.58**	**0.06**
Dog-rivalry	304	0.48 (0.07)	0.76 (0.06)	6.45	0.02
Dog-directed fear	343	1.12 (0.10)	1.04 (0.06)	< 1.00	0.01
Stranger-directed fear	**344**	**1.57 (0.13)**	**0.65 (0.07)**	**51.57**	**0.13**
Non-social fear	**344**	**1.98 (0.10)**	**0.98 (0.06)**	**87.56**	**0.20**
Touch sensitivity	**344**	**1.38 (0.10)**	**0.98 (0.06)**	**13.44**	**0.04**
Attachment/attention seeking	**344**	**2.27 (0.09)**	**1.73 (0.05)**	**37.11**	**0.10**
Separation related problems	344	0.87 (0.07)	0.98 (0.05)	I.35	0.00
Excitability	344	2.10 (0.08)	2.14 (0.05)	< 1.00	0.00
Chasing	**344**	**1.03 (0.10)**	**2.04 (0.07)**	**68.89**	**0.17**
Energy	344	1.97 (0.11)	1.72 (0.07)	3.73	0.01
Escape, roaming	**318**	**1.88 (0.15)**	**2.50 (0.09)**	**12.66**	**0.04**
Rolls in faeces	**335**	**1.33 (0.14)**	**1.94 (0.09)**	**12.39**	**0.04**
Coprophagia	337	1.68 (0.15)	1.32 (0.09)	4.41	0.01
Chewing	341	1.47 (0.12)	1.24 (0.08)	2.40	0.01
Mounting	340	0.39 (0.09)	0.52 (0.06)	1.32	0.00
Begging	343	2.06 (0.14)	2.05 (0.09)	< 1.00	0.00
Food stealing	341	1.48 (0.13)	1.84 (0.09)	4.38	0.01
Fear of stairs	**323**	**1.12 (0.13)**	**0.36 (0.06)**	**45.61**	**0.12**
Leash pulling	340	1.52 (0.13)	1.80 (0.08)	3.28	0.01
Urine marking	341	0.77 (0.11)	0.50 (0.07)	4.71	0.01
Emotional urination	343	0.38 (0.08)	0.20 (0.04)	5.02	0.02
Separation urination	338	1.04 (0.12)	0.75 (0.07)	4.95	0.03
Separation defecation	337	0.80 (0.10)	0.56 (0.06)	4.41	0.01
Hyperactivity	343	0.85 (0.10)	0.76 (0.06)	< 1.00	0.00
Compulsive staring	335	0.95 (0.11)	0.68 (0.07)	4.56	0.01
Snap at imaginary flies	334	0.14 (0.06)	0.30 (0.05)	3.45	0.01
Tail chasing	340	0.21 (0.06)	0.29 (0.04)	< 1.00	0.00
Shadow chasing	332	0.27 (0.06)	0.32 (0.05)	< 1.00	0.00
Excessive barking	344	1.50 (0.15)	1.61 (0.09)	< 1.00	0.00
Self-grooming	344	0.93 (0.11)	1.02 (0.08)	< 1.00	0.00
Allogrooming	344	0.80 (0.11)	0.76 (0.07)	< 1.00	0.00
Abnormal, stereotypical behaviours	**311**	**1.42 (0.17)**	**0.56 (0.08)**	**29.77**	**0.09**

[a]The first 14 lines represent scores from the categories of behaviours assessed. The last 22 lines represent scores on the individual behaviours assessed; [b]The different *N*s reflect the number of responses for subscales or individual behaviours
Significant differences using the criteria $P \leq 0.001$ 4 are represented in bold
The table presents all the between group differences for the former laboratory and convenience sample, including the means (M), standard error of the means (SE), F scores, and effect sizes (η^2), with 0.01 representing a small effect, 0.06 a medium effect, and 0.12 or higher a large effect

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haviour, the means (M), standard error of the means (SE), *F* scores and partial eta square (η^2) values are reported; see Table 2 for the individual number of Beagles in each group expressing the behaviour].

Table 2. The number (*N*) and percentages of Beagles from each sample who were reported as displaying each of the individual behaviours or categories of behaviours

C-BARQ categories or individual behaviours	Beagle sample			
	former laboratory (100)		convenience (244)	
	N	percentages (%)	*N*	percentages (%)
Trainability	100	100.00	244	100.00
Stranger-directed aggression	44	44.00	153	62.70
Owner-directed aggression	32	32.00	110	45.08
Dog-directed aggression	43	43.00	169	69.26
Dog-rivalry	58	58.00	161	65.98
Dog-directed fear	79	79.00	186	76.23
Stranger-directed fear	77	77.00	121	49.59
Non-social fear	98	98.00	215	88.11
Touch sensitivity	90	90.00	195	79.92
Attachment/attention seeking	100	100.00	244	100.00
Separation related problems	85	85.00	204	83.61
Excitability	99	99.00	244	100.00
Chasing	71	71.00	231	94.67
Energy	92	92.00	218	89.34
Escape, roaming	82	82.00	220	90.16
Rolls in faeces	59	59.00	185	75.82
Coprophagia	67	67.00	138	56.56
Chewing	75	75.00	156	63.93
Mounting	23	23.00	75	30.74
Begging	86	86.00	196	80.33
Food stealing	71	71.00	186	76.23
Fear of stairs	59	59.00	67	27.46
Leash pulling	73	73.00	196	80.33
Urine marking	44	44.00	58	23.77
Emotional urination	23	23.00	31	12.70
Separation urination	57	57.00	98	40.16
Separation defecation	53	53.00	79	32.38
Hyperactivity	52	52.00	116	47.54
Compulsive staring	53	53.00	95	38.93
Snap at imaginary flies	14	14.00	44	18.03
Tail chasing	15	15.00	47	19.26
Shadow chase	22	22.00	52	21.31
Excessive barking	62	62.00	163	66.80
Self-grooming	53	53.00	127	52.05
Allogrooming	43	43.00	100	40.98
Abnormal, stereotypical behaviours	57	57.00	80	32.79

The first 14 lines represent the number of dogs from each sample reported for the categories of behaviours assessed. The last 22 lines represent the number of dogs from each sample who were reported as exhibiting each of the individual behaviours assessed

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Table 3. Results of the ANOVAs comparing the former laboratory and shelter and stray subset samples

C-BARQ categories or individual behaviours		Beagle sample			
		former laboratory	shelter strays subset		
	N[a]	M (SE)	M (SE)	F	η^2
Trainability	205	2.15 (0.05)	1.95 (0.06)	5.47	0.03
Stranger-directed aggression	203	0.23 (0.04)	0.46 (0.06)	8.36	0.04
Owner-directed aggression	205	0.18 (0.04)	0.24 (0.05)	0.87	0.00
Dog-directed aggression	**198**	**0.44 (0.07)**	**1.05 (0.11)**	**21.65**	**0.99**
Dog-rivalry	180	0.48 (0.07)	0.68 (0.11)	2.35	0.01
Dog-directed fear	198	1.12 (0.10)	1.06 (0.10)	< 1.00	0.00
Stranger-directed fear	**205**	**1.57 (0.13)**	**0.63 (0.09)**	**35.49**	**0.15**
Non-social fear	**205**	**1.98 (0.10)**	**1.01 (0.09)**	**50.56**	**0.20**
Touch sensitivity	198	1.38 (0.10)	0.84 (0.08)	16.94	0.08
Attachment/attention seeking	204	2.27 (0.09)	1.90 (0.08)	9.98	0.05
Separation related problems	205	0.87 (0.07)	1.15 (0.10)	5.43	0.03
Excitability	206	2.10 (0.08)	2.09(0.08)	< 1.00	0.00
Chasing	**201**	**1.03 (0.10)**	**2.17 (0.10)**	**63.13**	**0.24**
Energy	206	1.97 (0.11)	1.63 (0.10)	5.04	0.02
Escape, roaming	**181**	**1.88 (0.15)**	**2.82 (0.13)**	**21.86**	**0.11**
Rolls in faeces	201	1.33 (0.14)	1.88 (0.15)	7.23	0.04
Coprophagia	199	1.68 (0.15)	1.32 (0.15)	3.06	0.02
Chewing	204	1.47 (0.12)	1.12 (0.12)	4.01	0.02
Mounting	203	0.39 (0.09)	0.32 (0.08)	< 1.00	0.00
Begging	206	2.06 (0.14)	1.78 (0.13)	2.09	0.01
Food stealing	204	1.49 (0.13)	1.70 (0.14)	I.27	0.01
Fear of stairs	**196**	**1.12 (0.13)**	**0.25 (0.06)**	**37.98**	**0.16**
Leash pulling	202	1.52 (0.13)	1.90 (0.13)	4.20	0.02
Urine marking	204	0.77 (0.10)	0.62 (0.11)	< 1.00	0.01
Emotional urination	205	0.38 (0.08)	0.14 (0.05)	7.24	0.03
Separation urination	202	1.04 (0.12)	0.97 (0.11)	< 1.00	0.00
Separation defecation	201	0.80 (0.10)	0.60 (0.10)	2.14	0.01
Hyperactivity	206	0.85 (0.10)	0.69 (0.09)	I.40	0.01
Compulsive staring	199	0.95 (0.11)	0.60 (0.09)	5.70	0.03
Snap at imaginary flies	196	0.14 (0.06)	0.32 (0.08)	3.81	0.02
Tail chasing	202	0.21 (0.06)	0.32 (0.07)	1.15	0.01
Shadow chasing	196	0.27 (0.06)	0.27 (0.07)	< 1.00	0.00
Excessive barking	206	1.50 (0.15)	1.60 (0.14)	< 1.00	0.00
Self-grooming	206	0.93 (0.11)	1.08 (0.13)	< 1.00	0.00
Allogrooming	206	0.80 (0.11)	0.78 (0.11)	< 1.00	0.00
Abnormal, stereotypical behaviours	**183**	**1.42 (0.17)**	**0.71 (0.12)**	**11.65**	**0.06**

[a]The first 14 lines represent scores from the categories of behaviours assessed. The last 22 lines represent scores on the individual behaviours assessed; [b]The different *N*s reflect the number of responses for subscales or individual behaviours
Significant differences using the criteria $P \leq 0.001$ 4 are represented in bold
The table presents all the between group differences for the former laboratory dogs compared to the subset of shelter and stray dogs from the convenience sample. The table includes the means (M), standard error of the means (SE), *F* scores, and effect sizes (η^2), with 0.01 representing a small effect, 0.06 a medium effect, and 0.12 or higher a large effect

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The former laboratory Beagles were rated by their caregivers at the time of evaluation as significantly more fearful of strangers, exhibiting more non-social fear, and as having an increased fear of stairs relative to the ratings for the convenience sample. They also were reported as having increased sensitivity to touch. Despite the increased levels of fear, the dogs from the laboratories were significantly less aggressive towards strangers and other dogs. They also exhibited increased attachment and attention seeking behaviours, and more frequently engaged in abnormal, stereotypical behaviours. The Beagles from laboratories were less likely to chase other animals, escape from their households, or roll in faeces. There were no differences in the other 7 categories or 18 individual behaviours assessed (see Table 1).

Given that the significant differences in the ratings may be a result of the former laboratory Beagles coming from a "second hand" origin, a second set of 36 ANOVAs were run using the subset of dogs from the convenience sample who came from shelters or were strays. The same conservative alpha set at $P < 0.001\ 4$ was used for this analysis (see Table 3).

Those tests revealed significant differences on 5 of the 14 categories (36%) and on 3 of the 22 (14%) individual behaviours assessed. This means that four significant differences found in the original analysis with the full convenience sample did not persist when only comparing the laboratory dogs to dogs from shelters. This included differences in the stranger-directed aggression, sensitivity to touch, attachment and attention seeking, and rolling in faeces. The differences that remained, however, included the dogs from the laboratories being significantly less aggressive towards other dogs, having increased reports of fear towards strangers, non-social situations, and stairs. The dogs from the laboratories also had increased reports of abnormal behaviours, were less likely to chase other animals, and less likely to escape (all $P < 0.001\ 4$; see Table 3).

DISCUSSION

The purpose of this study was to assess whether there were differences in the emotional and behavioural characteristics between Beagles rehomed from laboratories and a convenience sample from more traditional settings (e.g., breeders, shelters). Based upon previous research focused on dogs in laboratories, we hypothesised that these individuals would be reported as being more fearful, and engaging in more abnormal behaviours compared to the convenience sample. We also expected the Beagles from the laboratories would have increased attachment to their caregivers and seek more attention, but would not differ on many of the everyday behaviours assessed.

Given the similar pattern of findings regarding increases in fear and decreased aggression in the former laboratory dogs compared to the full convenience sample and subset of shelter dogs, we can infer that most of the differences revealed are a result of their experiences or time in the laboratory, and not as a result of coming from secondary sources. Therefore, we will discuss the findings from the comparison with the full convenience sample below.

Majority of everyday behaviours

As expected, we found no significant differences between the two samples of dogs on 7 of the 14 categories of behaviours and 18 of the 22 individual behaviours assessed. This includes behaviours that are typically deemed undesirable. There were no differences in separation-related behaviours, including engaging in destructive behaviours, excessive trembling, or salivating. There were also no increases in reports of emotional urination, defecation, hyperactivity, mounting, food stealing, dog rivalry, owner directed aggression, or excessive barking. There was also no difference in their ratings of trainability, meaning they can obey simple commands and respond positively to correction (Hsu and Serpell 2003). The scores from our convenience sample mirror those results found in other publications of C-BARQ scores for Beagles (Serpell and Duffy 2014).

Additionally, the dogs from the laboratories were reported to be significantly less likely to chase cats, birds, or other animals, escape from their home, or roll in faeces, indicating the dogs from the laboratories were actually rated more favourably on these characteristics.

This supports the idea that dogs adopted from laboratories are emotionally and behaviourally similar in many ways to dogs acquired from non-laboratory settings, and have many characteristics that make them "good" companions. This also

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demonstrates their resiliency since many laboratory environments lack environment enrichment and ample space to roam freely, which inhibits the dogs' autonomy. This complements the findings from other studies that found that former laboratory dogs exhibit "desirable" behaviours (Doring et al. 2017a; Doring et al. 2017b; Hanninen and Norring 2020). Doring et al. (2017a) and Doring et al. (2017b) also found that these desirable behaviours increased the longer they are out of the laboratories.

Increased fearfulness

Despite not finding differences on most of the behaviours assessed, there were significant differences regarding increased fearfulness. While previous research using the C-BARQ has found that Beagles are generally a fearful breed (Serpell and Duffy 2014), we found the Beagles from the laboratories were reported by their caregivers as being twice as fearful when approached by strangers and of non-social situations, which includes reacting fearfully to sudden or loud noises, to unfamiliar objects or situations (Hsu and Serpell 2003). They were also reported as being three times as fearful of stairs as Beagles from our convenience sample. It is possible that this increased fear was in response to all the novel stimuli they were experiencing outside of the laboratory, including natural substrates, stairs, and new people. Given the average age at the time of acquisition and age at the time of evaluation of the former laboratory dogs, it is estimated that they were living in their adoptive homes for approximately two years. It is possible this length of time was not great enough to see decreases in these fear responses. However, Hanninen and Norring (2020) found that Beagles released from laboratories had generalised fear that persisted up to four years after rehoming.

Fear generalisation is a common reaction to stress from experimental settings (Daskalakis et al. 2013). It is possible that inappropriate early-life experiences, including a potential lack of socialisation, confinement, stress, and disrupted attachment relationships might have occurred in the laboratories, which produced enduring changes in the brain structure and function (Daskalakis et al. 2013). It is these potential changes which may result in persistent fear responses, fear generalisation, and an inability to extinguish fear (Foa et al. 1992; Beerda et al. 1999; Beerda et al. 2000; McMillan et al. 2015).

The fear of strangers may also explain why we found significant increases in the sensitivity to touch, defined as fearful responses to potentially painful procedures, including veterinary examinations, bathing, grooming, and nail clipping (Hsu and Serpell 2003). It is possible that the caregivers are actually reporting increased sensitivity to procedures that are uncomfortable due to the environment the procedure is being performed in (Riemer et al. 2021), and not necessarily painful procedures. While Doring et al. (2017b) reported that a majority of former laboratory Beagles tolerated touch well, they did not compare the degree of toleration to a non-laboratory sample, rendering their results merely descriptive. It is also possible that given their older age at the time of acquisition, their increased fearfulness to strangers and touch was a result of being adopted past their ideal socialisation period (Boxall et al. 2004; Doring et al. 2017b). This is consistent with Hanninen and Norring's (2020) findings that even four years after adoption, Beagles rehomed from laboratories who were both older (8 years old) and younger (2 years old) were described as being anxious, fearful, and had separation anxiety.

Overall, these results suggest that the dogs from the laboratories were reported as being more fearful than the convenience sample of dogs. Previous research has established that most caregivers actually underestimate the fearfulness and anxiety in their dogs (Grigg et al. 2021). Therefore, it is possible that the individuals who adopted dogs from laboratories, having an understanding of what their dogs may or may not have experienced in the laboratories, made them more attuned to this fear than the caregivers of the convenience sample of dogs, and that no real differences exist. However, this may also be true for caregivers who adopt dogs from shelters. Given we still found a significant difference when comparing the dogs from laboratories to those from shelters, we can infer the increased fearfulness may be a result of experiences in the laboratory, including a lack of socialisation or early experiences, or other hereditary factors, and not differences in the sensitivity to the perceived fear by their caregivers.

Reports of exaggerated and generalised fear in dogs who have experienced near life-threatening cir-

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cumstances have been diagnosed as canine post-traumatic stress disorder (CPTSD) (Dao 2011; Brait 2015). Specifically, CPTSD has been reported in military working dogs, or dogs who have been seriously injured.

While we do not know what the dogs in our laboratory sample endured, we do know they are primarily used in disease research, and toxicity testing, and that 27% of the dogs used in research in the US were used in protocols that included painful, distressing procedures (United States Department of Agriculture 2019). This may mean that some of these dogs did indeed experience circumstances that were traumatising.

Changes in behaviour associated with diagnoses of CPTSD include generalised fearfulness, being easily startled, always on guard, and avoiding specific people or situations. They also include increased timidity, seeking out attention, engaging in abnormal behaviours, having difficulty following commands, and having increased bouts of aggression.

Some of these behaviours may map onto behaviours assessed with the C-BARQ, including stranger-directed fear, non-social fear, separation-related behaviours, attachment and attention seeking, decreased trainability, increased excitability, and increased stranger-directed aggression.

While we did not find significant differences on many of these behaviours assessed, particularly those relating to aggression, most dogs who have been diagnosed with CPTSD are military German Shepherds who are generally rated on the C-BARQ as an aggressive breed (Bray et al. 2021), and more aggressive than Beagles (Serpell and Duffy 2014). Therefore, it is possible that the increased levels of fear reported in the Beagles from laboratories itself may be indicative of CPTSD. This is a potential area for future research.

In order to combat fearfulness, socialisation programmes and habituation are recommended for dogs prior to being rehomed to potentially reduce some of this fearfulness (Hanninen and Norring 2020).

The careful selection of new owners is also important when rehoming dogs from laboratories. They should be educated on avoiding situations that may provoke fear and should be encouraged to seek behavioural therapy for their dogs if fear persists and they cannot be habituated to environmental stimuli (Doring et al. 2017b).

Attachment and attention behaviours

Our results revealed that the dogs from the laboratories were reported as exhibiting increased attachment and attention-seeking behaviours relative to the convenience sample. This includes the tendency to stay close to their caregivers, solicit affection and attention, and become agitated if their caregiver gives attention to others (Hsu and Serpell 2003). Proximity and attention seeking is a common reaction of dogs who are experiencing fear or stress (Grigg et al. 2021). Some dogs who have had unstable early-life experiences and increased fearfulness have increased separation anxiety (McMillan et al. 2015; Tiira et al. 2016; Doring et al. 2017b), however, the dogs from the laboratories in our sample did not have significant increases in separation related behaviours, separation urination, or defecation. Others using the C-BARQ have found that human caregivers have reciprocal increased attachment to their dogs (Hoffman et al. 2013). Together, these findings support the idea that increased attachment and attention seeking behaviours are not interpreted as problematic, nor do they dissuade individuals from adopting these dogs.

Decreased reports of aggression

Despite the former laboratory Beagles' increased fear of strangers, this fear did not translate to aggression. While Beagles are generally a less aggressive breed (Serpell and Duffy 2014), we found that those dogs rehomed from the laboratory were significantly less aggressive towards strangers who approached or invaded their space and were less aggressive when approached by unfamiliar dogs than the convenience sample. Doring et al. (2017b) also reported no aggressive incidents in their rehomed Beagle sample. It is possible that the decreased rates of aggression are a result of aggressive Beagles not being rehomed from laboratories, or because laboratory dogs are purpose-bred for decreased aggression.

Increased reports of abnormal behaviours

The results of the ANOVA supported our hypothesis of increased reporting of abnormal behaviours in the former laboratory Beagles. When looking

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at the open-ended comments, fifty caregivers provided miscellaneous comments about their dogs' behaviours. Many of these comments would fall under previously assessed categories (e.g., non-social fear, staring into space); however, some of the comments may be considered indicative of abnormal behaviours. This includes caregivers who report their dog sits motionless in the middle of the room "like she is afraid to move", that their dog constantly eats toilet paper, or the dogs bite or chew themselves. Without interviewing the caregivers, or directly observing the dogs, it is important to interpret these reports and results cautiously. Reports of abnormal repetitive behaviours have been reported in restrictively reared, chronically stressed dogs in laboratories (Hetts et al. 1992; Beerda et al. 1999; Beerda et al. 2000; Araujo et al. 2013), and dogs who experienced abuse (McMillan et al. 2015). However, we did not find differences in any other miscellaneous behaviours often associated with the broader category of abnormal behaviours, including staring into space, ingestion of faeces, chasing of tails, or snapping at imaginary flies.

Some abnormal behaviours are coping mechanisms for stress or boredom (McMillan et al. 2015; Scullion Hall et al. 2017). This may be the case with the abnormal behaviours reported here. These behaviours may be reverted to when anxious, frustrated, or in times of conflict (Ferdowsian and Merskin 2012; McMillan et al. 2015) and may persist in situations when there is no anxiety, frustration, or conflict (Tynes and Sinn 2014). Or the behaviours may simply be normal dog behaviours that the caregivers have not observed before. Therefore, the findings that the dogs from the laboratories were reported as engaging in abnormal repetitive behaviours more often than the convenience sample do not imply that they are living in situations where their welfare is currently diminished.

Limitations

The results of our study revealed clear differences between the two groups on some of the behaviours analysed. Knowing what caused these differences, however, can only be inferred based upon their documentation of being in a laboratory or not, as we do not know the complete history of the dogs in either sample. It is possible that some laboratory dogs were not used in invasive experimentation, or were housed in enriched social environments. It is also possible that the dogs in our convenience sample lived in homes where their social, emotional, or behavioural needs were not met. Despite the lack of complete histories for either sample, significant differences emerged between the two groups on some of the subscales and behaviours assessed.

We acknowledge that despite the significant differences between the two groups on some of the behaviours reported, these differences may not translate to significant functional differences. For example, the mean score on stranger-directed aggression for the former laboratory Beagles was a 0.23 out of 4 possible points, while it was a 0.53 for the convenience sample. Both samples are generally not very aggressive. The mean score of a 1.98 out of 4 on non-social fear for the former laboratory dogs, however, may translate into more observable differences for those dogs relative to the convenience sample whose score was 0.98. It is important to take the scales on which these scores are measured into consideration when interpreting the scores, in addition to comparing the two groups.

We also must consider potential biases of caregivers when completing the C-BARQ survey. It is possible that caregivers' knowledge of the dogs' experiences in the laboratory influenced their responses. It is unclear, however, whether such knowledge would make them more inclined to report problems or not. Caregivers might minimise behavioural problems out of fear that any negative results will reflect poorly on them, or on the dogs who may potentially be rehomed from laboratories (McMillan et al. 2015).

There is increased interest from laboratories (Carbone et al. 2003; Doring et al. 2017b; Skidmore and Roe 2020), legislators, and the pubic in retiring dogs from laboratories. This makes it important to understand the beagles' emotional and behavioral characteristics to help facilitate the rehoming process. While there were increases in fear, abnormal repetitive behaviours, and attachment and attention seeking in the Beagles from the laboratories, it is important to reemphasise that there were no significant differences in the majority of the behaviours and subscales assessed. This means that both the former laboratory and non-laboratory dogs had similar scores on a number of characteristics which make dogs "good" companions.

Despite any special needs these dogs may have, the BFP has reported a waiting list of over 9 000 fami-

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lies and individuals interested in caring for these dogs (Lopresti-Goodman 2017). Other researchers have found that emotional and behavioural issues do not impair the bonds between dogs and their caregivers (McMillan et al. 2015). Indeed, the dogs from the laboratories seemed to have increased attachment to their caregivers, which, based upon unsolicited responses from the caregivers, is welcomed and reciprocated.

Our findings support the research of others demonstrating these dogs can be rehomed successfully, form strong bonds with their caregivers, and make equally good companions as their non-laboratory counterparts, and support the ongoing work by laboratories and animal rescue organisations to offer these dogs for adoption.

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Conflict of interest

The authors declare no conflict of interest.

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