Research Article

Behavior of Laboratory Dogs Before and After Rehoming in Private Homes

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Summary

Although the rehoming of laboratory dogs has gained popularity, a scientific evaluation of the process is lacking. The behavior of 145 laboratory beagles was tested before leaving a research facility (Test 1). The new owners were then surveyed using a standardized telephone interview 1 week (n = 143) and 12 weeks (n = 126) after adoption. The behavior test was repeated with 68 dogs in their new homes 6 weeks after adoption (Test 2). The predictive power of Test 1 or Interview 1 on Test 2 or Interview 2, respectively, as well as the relevance of various factors was analyzed. We found no significant differences between Tests 1 and 2 regarding the behavior reactions. However, body language scores and heart rates changed significantly, indicating a more relaxed state of the dogs in their new homes. The interviews revealed a significant change toward desired behavior in most dogs within the 11 week period (p < 0.0001). The main behavior problems included separation problems (28%; n = 126), destroying objects (24%), and not being housebroken (39%). Owners of 9 dogs returned the animals, resulting in a rehoming success rate of 94%. Test 1 revealed a significant age effect (p = 0.0066), with younger and older dogs reaching higher scores than dogs who were approximately 2 years old. Dogs that had been born and reared in the research facility scored higher than dogs that had originally been acquired from a commercial breeder (p = 0.0257). The predictive power of Test 1 on Test 2 or Interview 1 on Interview 2 was moderate to low, respectively. Altogether, rehoming of laboratory dogs is a valuable alternative to euthanasia.

Keywords: adoption, behavior problem, behavior test, laboratory dog, rehoming

1 Introduction

Laboratory dogs are mainly used in pharmaceutical research (Joint Working Group on Refinement, 2004). They are the primary non-rodent species used in toxicological experiments (Smith et al., 2002). However, the public views the use of dogs in research with criticism. Euthanizing healthy laboratory dogs is not acceptable (Chanvin et al., 2012). As a result, the rehoming of laboratory dogs is gaining popularity. The European Directive 2010/63/EU (EU, 2010; recital no. 26) states: "(…) animals such as dogs and cats should be allowed to be rehomed in families since there is a high level of public concern about the fate of such animals." According to Carbone et al. (2003) adoption programs constitute an important refinement in humane animal care and use.

The laboratory dog's environment differs from the companion dog's environment in several aspects (Joint Working Group on Refinement, 2004). Laboratory dogs are housed in a relatively stimulus-poor environment. They rarely get to know everyday objects and sounds that companion dogs are confronted with in their daily lives. In some research facilities, the dogs are housed with no or limited access to outdoor runs and with no or limited possibility for spatial separation of functional areas (defecation and housing). As a result, many of the dogs are not housebroken. Laboratory dogs usually know only dogs of the same breed (mainly beagles) and sex, and they are often singly housed for a long time. Additionally, they have limited contact with humans and do not know children.

All these factors can cause adjustment problems after rehoming into private households, as supposed for separation-related behaviors, problems with housetraining, dog-to-dog communication problems, fear of people, a wide range of situational anxieties, specific fears, possible phobias (LASA, 2004) and fear-related aggression (Hubrecht, 2002). Only a few publications address this issue. They describe the rehoming experiences of the research facility and the new owners. Ake (1996), Carbone (1997) and Wyrick (1996) described the fact that most laboratory beagles are not housebroken as the main problem. Chanvin et al. (2012) rated anxiety to be the main problem. The LASA (2004)

believes that an objective assessment of the rehoming process is needed. They recommend an assessment of the behavior based on a scoring system with which the dogs should be scored before they leave the laboratory and during follow-up visits after the rehoming. However, such a study has not been published until now.

Therefore, the purpose of this study was to evaluate dogs' behavior before and after rehoming and to identify the problems that occur. To avoid future behavior problems in the new home, it is important to understand which factors influence the dogs' behavior and their ability to adapt to their new environment. For example, the LASA report proposed that puppies adapt better to a new home than adult dogs, that laboratory dogs may have difficulties interacting with children and that the presence of a canine companion is extremely desirable (LASA, 2004). Although a few studies examined factors that influence the rehoming success in rehomed shelter dogs (Wells and Hepper, 2000; Diesel et al., 2008), no such studies on rehomed laboratory dogs are available. Thus, we herein analyzed which factors affected the behavior of the rehomed laboratory dogs.

If it was possible to predict the behavior of laboratory dogs based on a behavior test before the rehoming, new owners could be selected and advised accordingly. We therefore analyzed whether or not the behavior test in the research facility can indicate the future behavior of the dogs.

2 Animals, materials and methods

2.1 Animals
The rehoming of 145 purpose-bred laboratory beagles – 65 males and 80 females – from a German pharmaceutical company was analyzed. At the time of rehoming, these dogs had an average (± standard deviation) age of 2.2 ± 1.5 years, with a range from 2 months to 7.9 years (27 dogs under 6 months, 44 dogs between 6 months and 2 years, 74 dogs older than 2 years). Thirty-six dogs had been purchased from a commercial breeder in the U.S., 9 dogs from a commercial breeder in Italy, and 70 dogs from 2 commercial breeders in Germany (Germany 1 n = 56, Germany 2 n = 14). Thirty dogs had been born and reared in the facility, the pregnant dams were purchased from the breeder in the U.S.

2.2 Housing in the research facility
The dogs were housed in indoor 6 m² kennels. Some of the kennels were connected to a 6 m² outdoor run, accessible from 08:00 h to 13:00 h. Dogs that did not have access to a run were placed singly or in pairs in a 12 m² outdoor pen once a day for 3-5 hours in the morning. 112 dogs were single housed (i.e., alone in the kennel), 6 dogs were kept in groups of 2, and 27 dogs – under 6 months of age – were kept with their siblings. The indoor kennels were equipped with plastic boxes (closed on five sides with an open front, 65 cm x 48 cm, height 50 cm) as a sleeping place. The dogs had visual contact with the other dogs. Wooden bite sticks, purchased from a local carpenter, and rubber balls stuffed with treats (Dog Activity Snackball, Trixie Heimtierbedarf GmbH & Co. KG, Tarp, Germany) were offered to the dogs as enrichment items. Dryfood (ssniff® HD Ereich, Extrudate Complete feed, Soest, Germany) was spread over the kennel floor once a day, the amount was adjusted to the body weight of the dogs. The following examinations and treatments were performed regularly: brushing the fur, trimming claws, drawing blood, general examinations as well as oral applications und vaccinations. During these procedures, the dogs stood on a table in an examination room and were rewarded with treats. The dogs were transported within the facility either in a special transport trolley or in the arms of an animal caretaker. As a result, the dogs did not get to know a leash and collar.

2.3 Rehoming
Two animal welfare organizations arranged the rehoming process. 72 dogs were placed into new homes by "*Laborbeaglehilfe*" (http://www.laborbeaglehilfe.de). Members of this organization picked them up in the laboratory and brought them directly to the new owners. If no immediate placement was possible, the dogs (13/72) were first placed in foster homes. Seventy-three dogs were placed through the animal shelter in Wermelskirchen (http://www.tierheim-wermelskirchen.de). The research facility transported the dogs to the shelter in (small) groups. These dogs waited on average 59.9 ± 71.9 days until placement, with the fastest placement taking 2 days and the longest 375 days. At the shelter Wermelskirchen, the dogs were kept in groups. During periods of warm temperatures, 2-6 dogs were housed in partially covered outdoor pens of 8-12 m². The pens were equipped with doghouses and sometimes with plastic dog beds. During periods of cold temperatures, groups of 1-3 dogs were housed in a building with kennels of 6 m² size. Both organizations held several meetings with the future owners to prepare them for their pet. In addition, they provided informational material on their websites and were available for consultation after the placement.

2.4 Methods
The investigations comprised behavioral studies and telephone interviews with the new owners. The dogs were individually tested using a standardized laboratory beagle test (Döring et al., 2016). The first test took place at the research facility about 1 week before the dogs were picked up by the animal welfare organizations. The second test was conducted in the new home 6 weeks after adoption with those dogs that had been placed within a radius of 200 km from the research facility (n = 74). The tests were performed by the same female investigator who was unknown to the dogs at the first test. To ensure a test environment that was as standardized as possible, the test area was surrounded by 70 cm high cardboard walls which were placed inside an empty room at the research facility (3.0 m x 4.5 m) or inside the living rooms of the new owners. The first test comprised 145 dogs. Due to technical problems, only the videos of 141 dogs could be evaluated. The collective of the second test was reduced by 6 dogs, which had to be excluded because they panicked when they were brought into the cardboard test arena, resulting in a final number of 68 dogs. After Test 2, each dog was taken for a walk to assess the dog's behavior in everyday situations (this observational test is not specified in this paper). In addition, all new dog owners – regardless of the distance – participated in a telephone questionnaire 1 week (Interview 1, n = 143) and 12 weeks after the placement (Interview 2,

n = 126). Before the interviews, the owners had to complete a consent form which they received from the welfare organization.

Behavior test
Both behavior tests followed the same standardized procedure (Tab. S1[1], S2[1]) based on the laboratory dog test of Döring et al. (2016) with slight modification. The tests were recorded with a camcorder that was placed on a tripod outside the test arena. The heart rate of the dogs was measured with a stethoscope (for 15 s) after the test sections provocation, examination and feeding. The videos were evaluated according to Döring et al. (2014, 2016). Behavioral reactions were recorded and scored as defined in Tables S1[1] and S2[1] and ranged from 0 (fearful/unwanted behavior) to 3 (relaxed/desired behavior). Playing, chasing, being covered by a cloth and feeding were not scored because we did not want to judge the associated behaviors as wanted or unwanted. The body language was scored as defined in Döring et al. (2014) with a range from 0.5 (submissive) to 3 (relaxed).

When multiple body postures occurred within a test section, the posture with the lowest score was used for calculation.

Interviews
The new owners were interviewed by telephone 1 and 12 weeks after placement. The interview included questions about the new owner and home (Tab. 1) and questions about the specific behavior of the dog in various situations (Tab. S3[1], S4[1]). These questions were read in sequence to the owner. First, the owner was allowed to give subjective answers, which were noted by the interviewer. Afterwards, the interviewer attempted to specify the answers by asking details about the dog's behavior. Examples included: "What is the dog doing specifically?", "What does the dog look like while performing this behavior?" During the evaluation of the interviews, the behaviors were divided into categories and scored. Because 7 dogs were in foster homes 1 week after leaving the facility, Interview 1 was done with their foster owners.

Tab. 1: Description of the variables used in the explorative statistical models (see Tab. 5)
Percentages (numbers) of dogs are given.

Variable	Description or question asked		
Housing in the laboratory	*Housing in the research facility*	*n* = 145	
Pair	Dog kept in paired housing	4% (6)	
Group	Dog kept in group housing	19% (27)	
Single	Dog kept in single housing	77% (112)	
Residential area	*How does the new owner describe the residential area of the home?*	*n* = 144	
Rural	Owner lives in a rural area	44% (63)	
City	Owner lives in a city	10% (14)	
Suburb	Owner lives in a suburb or residential neighborhood	47% (67)	
Child in household	*Does (at least) 1 child (≤15 years old) live in the household?*	*n* = 138	
Child	≥1 child	46% (63)	
Grandchild	≥1 grandchild	4% (6)	
None	No child or grandchild	50% (69)	
Partner dog	*Does another dog live in the new home?*	*n* = 145	
Yes	Another dog present	42% (61)	
No	No other dog present	58% (84)	
Experience of owner	*Experience of the new owner with dogs?*	*n* = 142	
No	Owner never had a dog	16% (23)	
Yes: previous dog	Owner previously had a dog but no hound dog or shelter dog	30% (43)	
Yes: hound dog or shelter dog	Owner previously had a hound dog or shelter dog	54% (76)	
		Interview 1	Interview 2
Dog training class	*Does the owner take the dog to dog training classes?*	*n* = 142	*n* = 125
Yes	Owner takes the dog to dog training classes	21% (30)	26% (33)
No	Owner does not take the dog to dog training classes	79% (112)	74% (92)

[1] Supplementary material at https://doi.org/10.14573/altex.1608171s

Variable	Description or question asked	Interview 1	Interview 2
Obedience training	*Does the owner conduct obedience training with the dog (outside of dog training classes)?*	*n* = 143	*n* = 124
Yes	Owner conducts obedience training	66% (94)	81% (101)
No	Owner does not conduct obedience training	34% (49) [a]	19% (23) [b]
Reward*	*How does the owner reward the dog?*	*n* = 143	*n* = 125
Dog treats	Owner rewards mostly with dog treats	80% (115)	86% (108)
Petting	Owner rewards mostly with petting	71% (102)	74% (93)
Praise	Owner rewards mostly with words	94% (134)	91% (114)
Play	Owner rewards mostly with play	0% (0)	1% (1)
Frequency of reward	*How often does the owner reward the dog per day?*	*n* = 142	*n* = 125
Rarely	Owner rewards <5 times per day with dog treats, words or petting	3% (4)	0% (0)
Occasionally	Owner rewards 5–20 times per day with dog treats, words or petting	27% (39)	35% (44)
Frequently	Owner rewards >20 times per day with dog treats, words or petting	70% (99)	65% (81)
Punishment* [c]	*What does the owner do when the dog shows unwanted behavior?*	*n* = 142	*n* = 125
Scolding	Owner shouts "Pfui" or "Aus" or "Nein" (which means "Leave it", "Drop it", "No") to interrupt the behavior	86% (122)	95% (118)
Smacking	Owner smacks the dog with a newspaper, holds dog down or shakes dog	1% (1)	6% (7)
Startling	Owner makes a noise to interrupt the behavior	1% (2)	2% (2)
Muzzle grip	Owner uses muzzle grip for training purposes	1% (1)	2% (2)
Nose in urine	Owner rubs the dog's nose in the urine while scolding the dog	1% (1)	2% (2)
Other	Other methods of punishment	3% (4)	3% (4)
Ignoring	Owner ignores the dog during the unwanted behavior unless ignoring is impossible (e.g., when the dog destroys something)	8% (11)	9% (11)
Frequency of punishment	*How often does the owner apply these methods?*	*n* = 140	*n* = 120
None	Owner does not use punishment during training	12% (17)	0% (0)
Rarely	Owner punishes the dog ≥3 times per week	31% (43)	53% (63)
Occasionally	Owner punishes the dog ≤3 times per day	17% (24)	18% (22)
Frequently	Owner punishes the dog >3 times per day	40% (56)	29% (35)

Interview 1: 1 week after adoption; Interview 2: 12 weeks after adoption

*Multiple responses possible, thus sum >100%

[a] Of these, 10 owners said: "Dog does not understand training methods" or "Does not work," 1 owner said: "Not possible," 3 owners said: "Dog is too fearful"

[b] Of these, 7 owners said: "Dog does not understand training methods" or "Does not work," 1 owner said: "Dog is too fearful"

[c] One owner in Interview 2 used all of these punishments except ignoring

Pilot test

Before starting the tests and interviews, the investigator performed a pilot test with an additional 10 laboratory beagles to practice the standardized test and questioning procedures. The pilot test included Test 1 in the facility, Test 2 in the new home as well as the telephone interviews (data not shown).

Intra- and inter-rater reliability

For the calculation of the intra-rater reliability, the videos of Test 1 were re-evaluated for 13 randomly chosen dogs by the same person. For calculation of the inter-rater reliability, a second person who was not otherwise involved in the study re-evaluated the videos of Test 1 of 3 dogs. All 241 traits including behavior parameters, body language and the occurrence of calming and stress signals in each test section were re-evaluated (except for reactions to leading, covering and feeding the dog).

2.5 Statistical analysis

We used the statistical software R version 3.1.2 (R Core Team, 2014) for the analyses. To investigate possible differences be-

tween the scores of Test 1 and Test 2 and of Interview 1 and Interview 2, paired t-tests were applied. To account for repeated measures, the Holm-Bonferroni method was used (to ensure that the global α of these tests did not exceed 0.05). To get an overall-value for each individual dog, a personality score was calculated as a mean of the behavior scores from the various test sections respective interview categories. For the personality score, we included all dogs for which we had obtained behavior scores in at least half of the test sections/categories. We tested for possible differences in the personality scores and heart rates using paired t-tests. To evaluate whether or not the dogs that were visited (because they were placed within 200 km) differed from those that were not visited, we used a two-sample t-test to compare the personality scores of Test 1.

The categories for activity in Tests 1 and 2 were calculated by assigning "high" to one-third of the dogs that passed the most squares on the grid, "low" to one-third of the dogs that passed the fewest squares on the grid and "moderate" to the remaining one-third of the dogs (Tab. S5[1]). Feeding, chasing, playing, activity and vocalization (Tab. S6[1]) were not scored but were assigned categories (yes/no for feeding, chasing or playing; low/moderate/high for vocalization or activity). To analyze correlations between the two types of data collection (tests and interviews), we applied Spearman's rank correlations (Fahrmeir et al., 2007). According to Fratkin et al. (2013), who found the personality of adult dogs to be more consistent than that of puppies, we furthermore calculated the correlations for those dogs ≥ 2 years of age.

The variables age, sex and breeder (in-house bred or commercial breeder) were chosen as main variables, and their effects were estimated using a mixed regression model (Fahrmeir et al., 2013). To evaluate the influence of individual breeders without adding too many variables to the model, they were included as random intercept. The mixed models were estimated using the function "gam" from the "mgcv" package (Wood, 2004, 2011). Each model initially included age as a non-linear effect (using penalized splines) to create a smooth age effect and was tested in a likelihood ratio test against the model with a linear age effect. Consequently, age was included as a non-linear effect in only one model. To evaluate a possible interaction between age and breeder, we conducted likelihood ratio tests between the models with and without the interaction. Consequently, an interaction between age and breeder was not included in any of the models.

To quantify the effect of additional variables (besides the main variables), we took an exploratory approach: through a forward Akaike information criterion (AIC) selection, we included in each model all those variables that created added value for the predictive power of the personality scores (Wood, 2004, 2011). The AIC is a goodness-of-fit measure that can be used to compare regression models to find out which is best at predicting the response variable. The basis for this approach was a mixed model that included each breeder as random intercept. The forward AIC selection is an iterative procedure that starts with fitting a "null model", which contains only the intercept and the random intercept but no covariates, and then step by step includes all the variables that lead to a "better" AIC

(for further details see Wood, 2004, 2011). The list of possible variables for the explorative model included age (linear effect), age (smooth effect), sex, breeder, rehoming organization, stay in shelter, residential area, garden, children, partner dog, experience of owner (dog owned previously?), attendance in dog training classes, obedience training, frequency of rewards, frequency of punishment (see Tab. 1; categories were partially combined); furthermore, the scores from Test 1 were included in Test 2, and scores from Interview 1 were included in Interview 2. For the variables attendance in dog training classes, obedience training and frequency of rewards and punishment, the number of owners differed between Interviews 1 und 2 (see Tab. 1); therefore, the variables of Interview 1 were selected for Test 1 and Interview 1, and the variables of Interview 2 were selected for Interview 2. For Test 2, the model was calculated twice: one model included the variables of Interview 1, the other the variables of Interview 2.

Dogs that had panicked and thus been excluded from Test 2 or sections thereof received scores of 0 and were included in the analysis.

The interpretation of the correlation coefficient (r) was done according to Martin and Bateson (2007) based on the scores of Sprinthall (2003); < 0.2, slight correlation, almost negligible relationship; 0.2 to < 0.4, low correlation, definite but small relationship; 0.4 to < 0.7, moderate correlation, substantial relationship; 0.7 to < 0.90, high correlation, marked relationship; 0.9 to 1.0, very high correlation, very dependable relationship.

In addition, we examined the following specific relationships: age at adoption and being housebroken after 12 weeks; age at adoption and behavior during isolation after 12 weeks; heart rate in Tests 1 and 2 and the according personality scores and body language scores; vocalization during isolation in Test 1 und behavior during isolation 1 und 12 weeks after adoption. The age groups puppies (< 0.5 years), juveniles (0.5-2 years) and adults (> 2 years) were those used by Wells and Hepper (2000) and Döring et al. (2014, 2016). With a t-test, we analyzed if vocalization during isolation in Test 1 differed between dogs kept in single versus group housing. The level of significance was 5% (α = 0.05). We analyzed the intra- and inter-rater reliability with the Bland-Altman method for continuous data and with Kappa statistics for ordinal and categorical data (Stata/IC 11.2 for Windows).

2.6 Policy and ethics
All facilities were registered according to §11 of the German Animal Welfare Act. Our study did not include animal experiments as defined by German legislation.
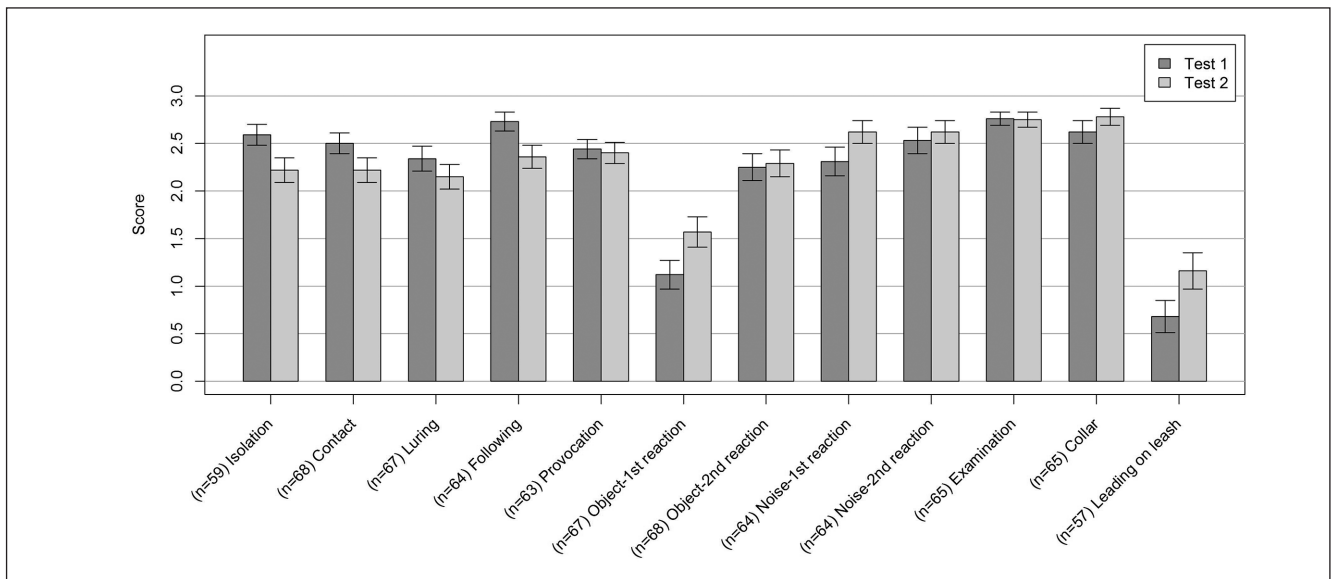
3 Results

3.1 Behavior tests
Behavior scores
Most of the dogs showed desired behavioral reactions, i.e., they were relaxed and sought contact, except in their first reactions to unknown objects and their leash-behavior (Tab. S1[1], S2[1]).

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[1] Supplementary material at https://doi.org/10.14573/altex.1608171s

Fig. 1: Comparison of the mean scores for behavior in Tests 1 and 2
Scores ranged from 0 to 3 (for scoring see Tab. S1[1]). Only those dogs that could be scored in both tests were included.
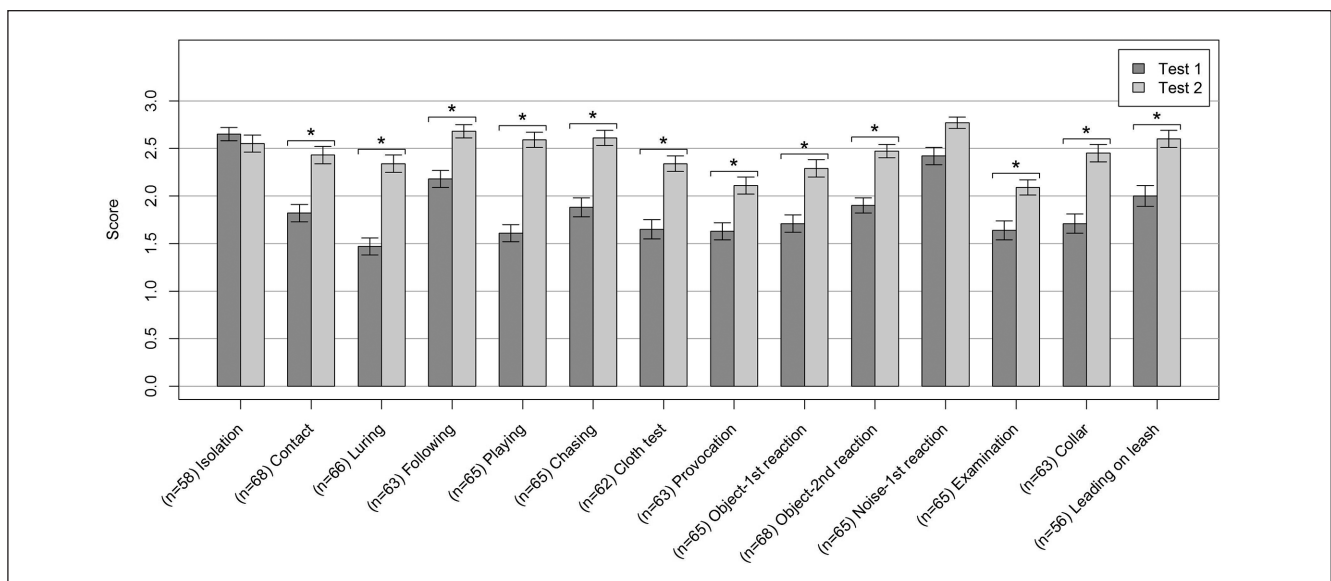
Fig. 2: Comparison of the mean scores for body language in Tests 1 and 2
Scores ranged from 0.5 (submissive) to 3 (relaxed/erect) according to Döring et al. (2014). Only those dogs that could be scored in both tests were included. *, $p < 0.05$ after Holm-Bonferroni adjustment.

With one exception, no aggressive reactions (growling, baring teeth, snapping or biting) occurred during the tests. Only one dog growled when the test person entered the test arena in Test 2. Comparison of behavior scores from individual dogs that had participated in both of the tests (n = 68) did not reveal any significant differences between Tests 1 and 2 for any parameter (Fig. 1). The personality scores (the mean of all behavior scores obtained in the various test sections per dog) did not differ between Tests 1 and 2 (p = 0.7547).

The personality scores of the dogs that were visited (because they were placed within 200 km) did not differ from those of the dogs that were not visited (p = 0.5944, Test 1).

Body language scores
Dogs that participated in both tests scored significantly higher in most body language sections of Test 2, i.e., they showed more relaxed body language during Test 2 than Test 1 (Fig. 2). The lowest scores were obtained with luring, playing, cloth test,

provocation, unknown object and examination, indicating a submissive body language.

Heart rate

Of the dogs that were measured in both tests, mean heart rates in Test 1 during all 3 measurements were higher than those in Test 2 (p < 0.001, paired t-test).

Intra- and inter-rater reliability

For the intra-rater reliability, 87.6% of the traits (n = 241) were an exact match in the 2 analyses with ratings from the same rater. The average (± standard deviation) degree of consistency (Kappa) was 0.96 (± 0.11). For the inter-rater reliability, 91.7% of the traits (n = 241) were an exact match in the 2 analyses with ratings from the 2 raters. The average degree of consistency (Kappa) was 0.93 (± 0.24). This concordance was sufficiently high to confirm the results.

3.2 Interviews

Information about the new homes and owners

A few new owners lived in the city, whereas most lived in suburbs or rural areas (Tab. 1). Most of the owners had experience with dogs as they had owned dogs before. Children up to 15 years old lived in about half of the households, and another dog was present in 42% of the households. The majority of the owners did not attend dog training classes, but they conducted obedience training on their own. Most of the owners used praise and dog treats to reward their dog. Owners' reactions to unwanted behavior were usually verbal ("*Pfui*", "*Aus*", "*Nein*", which means "Leave it", "Drop it", "No"), and only a few owners used physical punishment.
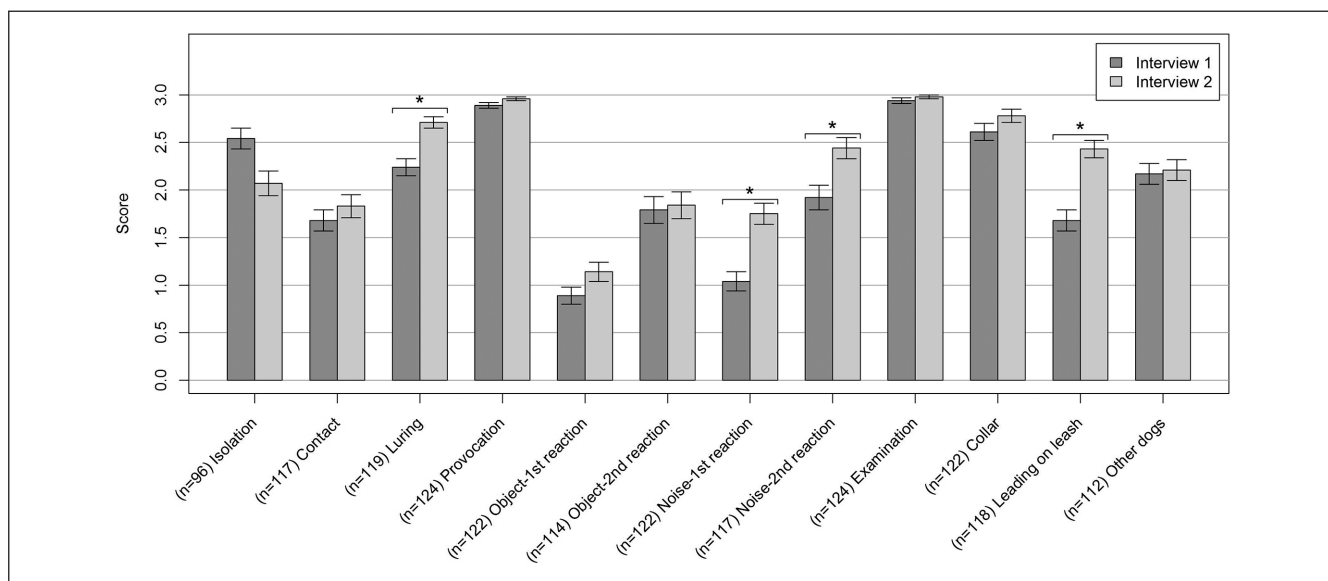
Behavior

During both interviews, most owners reported that the dog showed desired behaviors (Tab. S3[1], S4[1]). "Aggressive behavior" towards visitors was more frequently reported after 12 weeks, but it was always only expressed as barking except for 2 dogs: One dog snapped and 1 dog growled when an unknown person approached or leaned over the dog. According to the interviews, most of the dogs had a moderate activity level during the day and were calm during the night and when the owner pursued a calm activity (Tab. S5[1]). Most of the owners stated that their dog never or rarely vocalized. Frequent barking and howling increased slightly from Interview 1 to Interview 2 (Tab. S6[1]).

The mean behavior scores of all dogs whose owners participated in both interviews significantly increased from Interview 1 to Interview 2 with regard to luring, first and second reactions to noise and leash-behavior (Fig. 3). The personality scores showed an overall change toward desired behavior from Interview 1 to Interview 2 (p < 0.0001).

Behavior problems

The owners were not only asked to report any behavior that they perceived as disturbing but also questioned about specific problematic behaviors. In Interview 1, conducted 1 week after rehoming, 70% of the owners stated that their dog did not show any behavior perceived as disturbing even though 76% of the dogs were reported as not yet being housebroken (Tab. 2). In Interview 2, the percentage of reported problematic behaviors (66%) matched the percentage of owners who perceived these behaviors as disturbing (67%). Although the percentage of housebroken dogs increased (24% to 61%), that of dogs showing

Fig. 3: Comparison of the mean scores between Interviews 1 and 2

Scores ranged from 0 to 3 (for scoring see Tab. S3[1]). Contact = behavior with visitors; luring = luring by the owner. Only those dogs that could be scored in both interviews were included. *, p < 0.05 after Holm-Bonferroni adjustment.

Tab. 2: Behavior problems according to the telephone interviews with the new owners 1 week (Interview 1) and 12 weeks (Interview 2) after adoption
Description of the questions asked, definition of the behavior parameters, and test results (percentage (number) of dogs that showed the behavior).

Category	Description/Definition	Interview 1	Interview 2
Annoying problem?	*Does the dog show behavior perceived as annoying by the owner?*	(*n* = 143)	(*n* = 126)
no	no behavior is perceived as annoying	70% (100)	33% (41)
yes	one or more displayed behaviors are perceived as annoying	30% (43)	67% (85)
Do problems occur?	*Did the owner notice any of the following behavior problems in the dog?*		
separation-problems	dog barks, howls, whines or destroys objects when being alone in the home	(*n* = 138) 14% (19)	(*n* = 125) 28% (35)
destructive	dog destroys objects by biting or scratching	(*n* = 142) 16% (23)	(*n* = 126) 24% (30)
not housebroken	dog defecates or urinates in the home	(*n* = 143) 76% (108)	(*n* = 126) 39% (50)
aggressive	dog shows threatening behavior (barking, growling or baring teeth) and/or snapping or biting	(*n* = 143) 6% (9)	(*n* = 126) 11% (14)
bizarre	dog runs in circles, paces or bounces against the wall with his/her head turned backwards (the latter shown by 2 dogs)	(*n* = 143) 3% (5)	(*n* = 126) 6% (8)
none of these	dog does not show any of the above behaviors; owner mentioned other or no problems	(*n* = 138) 19% (26)	(*n* = 126) 34% (42)

Multiple answers were possible when a dog showed several problematic behaviors.

separation anxiety also increased (14% to 28%). The behaviors perceived as disturbing included "uncontrolled eating/begging/stealing food from table" reported by 16% (20 of 125) and "frequent barking" reported by 5% (6 of 125) in Interview 2.

Owner satisfaction and return rate
During both interviews, the new owners were asked if they would again decide to adopt a laboratory dog. During Interview 1, 90% (127 of 141 dog owners) said "yes", 4% (5) "no", 5% (7) "only as foster dog" and 1% (2) "I don't know". During Interview 2, 92% (113 of 123 dog owners) said "yes", 6% (7) "no" and 2% (3) "I don't know".

Within the 12 weeks of this study, 9 dogs (6.2%; n = 145) were returned to the animal welfare organization. For 5 dogs, the stated reason was the dog's behavior, for 3 of them aggressive behavior towards humans (one dog bit the owner, one dog defended food, one dog growled and snapped at children). Two dogs were returned because the owners developed an allergy and 2 because the owners felt that the new dog was "dominated" by the other dog in the home. All 9 dogs were placed in new homes, where the mentioned behaviors or problems did not occur (data not shown).

3.3 Correlation between the behavior tests and interviews
The comparison of results from Test 1 with those from Test 2 revealed low to moderate correlations for 11 of 17 parameters (Tab. 3). Most of the parameters were not correlated between the behavior tests and the interviews, except for contact (contact

behavior towards the test person in the behavior tests and towards visitors in the interviews) and vocalization. The statements of the owners in Interviews 1 and 2 showed low or moderate correlations for 10 of 17 parameters. The highest correlation was found for contact (towards visitors, r = 0.625) and playing (r = 0.560).

Considering only those dogs that were more than 2 years old during the first behavior test (before the rehoming), we found a few additional correlations (Tab. S7[1]).

3.4 Correlation between specially selected variables
There were only some low correlations between age at adoption and behavior problems (Tab. S8[1]). The younger the dogs the greater were the occurrences of separation-related problems and not being housebroken. Vocalization during the test section isolation in Test 1 (in the research facility) was not correlated with the behavior during isolation 1 or 12 weeks after adoption. However, vocalization during isolation in Test 1 occurred more often (p < 0.0001, t-test) in dogs that had been kept in groups than those that had been kept singly in the facility. Personality and body language scores showed low correlation with heart rate measurements in Test 1 and no correlation in Test 2 (Tab. S8[1]).

3.5 Influence of analyzed variables on the behavior of the dogs
The behavior of the dogs in Test 1 in the research facility was influenced by age (p = 0.0066, Tab. 4). Dogs that were about 1.5 to 2.5 years old received the lowest scores (Fig. 4), whereas both puppies and adult dogs (older than 2.5 years) received

Tab. 3: Correlation of behavior scores between behavior tests (Test 1 and Test 2, conducted before and 6 weeks after adoption, respectively) and phone interviews (Int 1 and Int 2, conducted 1 and 12 weeks after adoption, respectively) and of body language scores between both behavior tests (Spearman's rank correlation)

Test situation		Behavior score						Body language score
		Test 1 Test 2	Test 1 Int 1	Test 1 Int 2	Test 2 Int 1	Test 2 Int 2	Int 1 Int 2	Test 1 Test 2
Isolation	n	71	112	119	55	61	96	71
	r	0.0469	0.0101	-0.0788	-0.1666	-0.1172	0.2102	0.1796
Contact	n	72	131	119	67	64	117	72
	r	0.1136	0.3551	0.2398	0.2243	0.4346	0.6253	0.1365
Luring	n	71	137	115	70	63	119	70
	r	0.4056	0.1233	0.2380	0.0748	0.2525	0.2232	0.1168
Following	n	70	–	–	–	–	–	69
	r	0.3385	–	–	–	–	–	0.1806
Playing [a]	n	66	138	121	65	58	124	65
	r	0.1218	0.1766	0.1269	0.1624	0.2637	0.5600	0.1646
Chasing [a]	n	66	138	120	64	57	123	65
	r	0.4163	0.0103	0.1130	-0.0367	0.0738	0.2331	0.1606
Provocation [b]	n	70	138	121	68	62	124	70
	r	0.3366	0.0992	-0.0827	0.2417	-0.1672	0.1717	0.1187
Object, first reaction	n	71	136	120	70	64	122	65
	r	0.1831	0.0119	0.1064	0.0905	0.3768	0.2169	0.1433
Object, second reaction	n	73	134	115	70	63	114	73
	r	0.3529	0.1449	0.3055	0.1651	0.2581	0.1927	0.0849
Noise, first reaction	n	69	131	115	71	65	122	70
	r	0.2083	-0.0301	-0.0781	-0.0414	0.2210	0.2502	0.0386
Noise, second reaction	n	69	126	114	69	65	117	–
	r	0.3976	0.0938	-0.0737	0.0372	0.0821	0.2327	–
Examination [c]	n	72	136	120	71	65	124	72
	r	0.3557	-0.0328	0.1006	0.0022	0.1827	-0.0142	0.1908
Placing collar	n	72	136	119	71	65	122	71
	r	0.3500	0.1259	-0.0037	-0.0024	0.0368	0.1437	-0.0083
Leash behavior	n	62	120	104	66	61	118	60
	r	0.1674	-0.1112	0.0124	0.2230	0.1089	0.0769	0.0406
Feeding [a]	n	59	133	120	58	55	121	57
	r	0.3717	-0.0259	0.1337	0.2458	0.0216	0.1554	0.2606
Activity [a, d]	n	57	132	117	57	49	118	–
	r	0.1657	-0.1165	-0.1377	0.0274	-0.3629	0.2652	–
Vocalization [a, e]	n	61	137	118	58	53	121	–
	r	0.2635	0.3766	0.0915	0.3201	0.1324	0.1750	–
Other dogs	n	–	–	–	–	–	112	–
	r	–	–	–	–	–	0.2003	–

[a] Behavior was not scored, but presence/absence of behavior was determined (e.g., playing: Does dog play in Test 1 and Test 2, yes or no?).
[b] For Interviews 1 and 2, mean values were calculated from 3 manipulations: leaning over dog, carrying dog and pushing dog.
[c] For Tests 1 and 2, mean values were calculated from 4 examinations: ears, mouth, legs and auscultation.
[d] For activity levels see Tab. S5[1].
[e] For Interviews 1 and 2, mean values were calculated from 3 vocalizations: barking, howling and whining.

Colors: White: no correlation (< 0.2). Light gray: low correlation (0.2 to < 0.4). Dark gray: moderate correlation (0.4 to < 0.7).
High correlation (≥ 0.7) did not occur.

Tab. 4: Results from the correlation analysis between selected variables and the personality scores (sum of scores) in the respective tests and interviews (mixed regression model)

Test or interview	Variable	Estimate	p-value
Test 1	Intercept	2.0828	
Test 1	Sex: male	-0.0388	0.6264
Test 1	Breeder: commercial	0.1653	0.5888
Test 1	Age at Test 1	edf 3.3604[a]	0.0066*
Test 2 [b]	Intercept	0.5026	
Test 2 [b]	Disposition	0.8540	< 0.0001*
Test 2 [b]	Sex: male	-0.2727	0.0621
Test 2 [b]	Breeder: commercial	-0.2598	0.3756
Test 2 [b]	Age at Test 2	0.0101	0.8693
Interview 1	Intercept	2.2338	
Interview 1	Sex: male	0.0263	0.7053
Interview 1	Breeder: commercial	-0.2399	0.5761
Interview 1	Age at Interview 1	0.0164	0.6436
Interview 2 [c]	Intercept	1.9166	
Interview 2 [c]	Disposition	0.2802	0.0030*
Interview 2 [c]	Sex: male	-0.0283	0.7162
Interview 2 [c]	Breeder: commercial	-0.3753	0.0257*
Interview 2 [c]	Age at Interview 2	0.0268	0.4891

[a] Smooth terms: For each model, the likelihood ratio test was used to test if inclusion of the age effect as a smooth term improved the model significantly (compared with a model that included a linear age effect). Consequently, for Test 1, the age effect was estimated as smooth term and the estimated degrees of freedom (edf) are reported. For Test 2, Interview 1 and Interview 2, a linear age effect was included in the models.

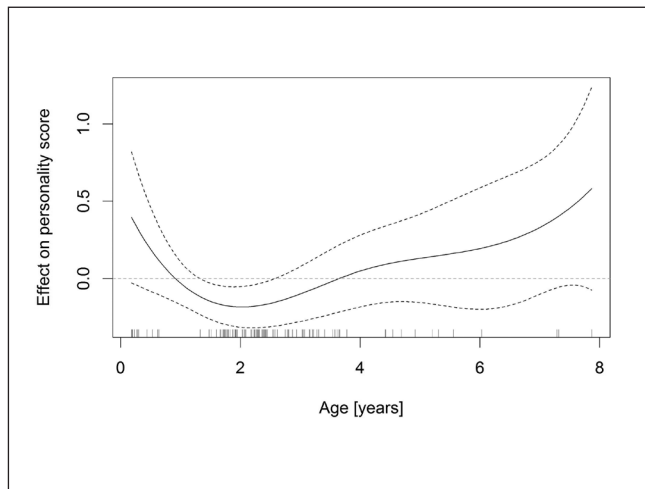[b] Personality score in Test 2 with personality score in Test 1 as covariate.

[c] Personality score in Interview 2 with personality score in Interview 1 as covariate.

* Significant with $p < 0.05$.

higher scores. Differences between the sexes were not found ($p = 0.6260$). With the exception of Test 1, dogs that had been purchased from commercial breeders scored lower than dogs that had been born in the research facility. This difference was significant for the data collected in Interview 2 ($p = 0.0257$). The average score estimate of -0.375 may be interpreted as follows: Considering all of the dogs that received the same score in Interview 1 and had the same age and sex, those dogs that had been purchased from commercial breeders received an average score that was 0.375 points lower than that of the in-house-bred dogs in Interview 2. The dogs from the German breeders scored lower than the dogs from the U.S. and the Italian breeder (Tab. S9[1]).

Furthermore, we found a significant effect of the dogs' disposition both in the tests and in the interviews, that is, the dogs that received high mean scores in Test 1 also received high mean scores in Test 2. The same trend, albeit less pronounced, existed between Interviews 1 and 2.

Further variables were analyzed with explorative models (Tab. 5). In Test 2, male dogs received lower scores than female dogs. They scored on average almost 0.5 fewer points than female dogs (estimate of -0.466 with the variables of Interview 1, estimate of -0.498 with those of Interview 2). No clear results were found regarding the variables children, presence of a garden, and frequent occurrence of punishment (i.e., verbal commands intended to interrupt a behavior). The presence of another dog and attendance in dog training classes were irrelevant; these variables did not create added value and thus were not included in any of the models. In contrast, obedience training had a positive effect: dogs whose owners performed obedience training scored 0.445 points more in Test 2 than dogs that were not trained. The dog-keeping experience of owners was included in only 1 model (in Interview 1), to which it added only a value of 0.242 score points.

Fig. 4: Age at Test 1 and its effect estimated as smooth function on the personality score
High scores indicate relaxed/desired behaviors. The tallies on the X-axis represent individual dogs. The continuous line represents the estimated effect. The dashed lines represent ± 2 standard deviations. The closer the dashed lines, the more exact is the estimated effect.

4 Discussion

Although the rehoming of laboratory dogs has been gaining popularity, a scientific evaluation of the adopted dogs' behavior is not yet available. Studies recommended in the LASA report (LASA, 2004) have not been published until now. Hence, we conceptualized a study to fill this knowledge gap, and included a greater number of animals than recommended in the LASA report to obtain meaningful results.

Although behavior scores did not change significantly between the two behavior tests, the body language scores increased. This higher level of relaxation was confirmed by a reduced heart rate during Test 2 compared with Test 1. The telephone interviews revealed that the dogs' behavior changed significantly toward desired behavior within 12 weeks after adoption. In particular, fearful reactions to noise decreased. This fast improvement suggests a high adaptability of the beagles and agrees with the observations of Aventis Pharma AG (Germany) presented in the LASA report (LASA, 2004): "Beagles seem to adapt easily to new situations." As expected, situational anxieties and specific fears occurred frequently but declined within 6-12 weeks after adoption to a level that did not exceed those of rehomed shelter dogs and companion dogs (Tab. 6).

Fear-related aggression or communication problems with dogs of other breeds were previously presumed to occur (Hubrecht, 2002; LASA, 2004). These concerns were not confirmed by our study. In contrast, the beagles behaved aggressively only on rare occasions, with an incidence that was much lower than that seen in adopted shelter or other companion dogs (Tab. 6). Furthermore, the beagles showed a high level of tolerance during all test provocations and examinations. These results agree with a previous study (Döring et al., 2014), in which

Tab. 5: Results from the explorative models testing for a correlation between selected variables and the personality scores (sum of scores) in the respective tests and interviews (mixed regression model with forward AIC selection)

Test or Interview	Variable	Estimate
Test 1	Intercept	2.1940
Test 1	Age at Test 1	edf 3.2247 [a]
Test 2 [b]	Intercept	0.1200
Test 2 [b]	Disposition: score of Test 1	0.9664
Test 2 [b]	Sex: male	-0.4663
Test 2 [b]	Garden	0.0426
Test 2 [b]	Punishment: frequent	0.0807
Test 2 [b]	> 2 adults, no child	-0.3465
Test 2 [b]	At least 1 child	0.0197
Test 2 [c]	Intercept	-1.0067
Test 2 [c]	Disposition: score of Test 1	1.0565
Test 2 [c]	Sex: male	-0.4980
Test 2 [c]	Garden	0.3497
Test 2 [c]	> 2 adults, no child	-0.0406
Test 2 [c]	At least 1 child	0.2162
Test 2 [c]	Rewards: frequent	0.2576
Test 2 [c]	Obedience training	0.4445
Interview 1	Intercept	1.5737
Interview 1	Garden	0.1568
Interview 1	Punishment: frequent	0.1634
Interview 1	> 2 adults, no child	-0.0864
Interview 1	At least 1 child	0.0105
Interview 1	Rewards: frequent	0.2156
Interview 1	Experienced with dogs	0.2418
Interview 1	Rehoming organization: shelter	-0.0698
Interview 1	Stay in shelter	-0.0011
Interview 2	Intercept	1.3682
Interview 2	Age at Interview 2	edf 1.8501[a]
Interview 2	Disposition: score of Interview 1	0.2865
Interview 2	Garden	-0.1480
Interview 2	Punishment: frequent	0.0478
Interview 2	>2 adults, no child	-0.0872
Interview 2	At least 1 child	0.1371
Interview 2	Obedience training	0.1120
Interview 2	Rehoming organization: shelter	0.3115
Interview 2	Residential area: suburb	0.1667
Interview 2	Residential area: city	-0.1976

For definition of variables see Tab. 1.
[a] Inclusion as smooth terms, thus with estimated degreesof freedom (edf).
[b] Personality score in Test 2 according to the variables in Interview 1.
[c] Personality score in Test 2 according to the variables in Interview 2.

Tab. 6: Prevalence of behavior problems in companion dogs reported in previous studies
Note that there are differences in defining the behaviors and in the methods that were used for the surveys.

Study	Wells and Hepper (2000)	Marston et al. (2005)	Herron et al. (2014)	Christensen et al. (2007)	Elliott et al. (2010)	Martínez et al. (2011)	Guy et al. (2001)	Blackwell et al. (2013)
Number of dog owners	n = 556	n = 62	n = 133	n = 67	n = 193	n = 232	n = 3,326	n = 4,280 n = 383
Rehomed shelter dogs	x	x	x	x	x*			
Survey in clinic or practice						x	x	x
Other locations								x
Behavior problem								
Separation-problems	–	32.3%	16.8%	–	42.6%	20.3%	–	–
Destructive	24.5%	38.7%	–	–	17.8%	21.1%	–	–
Not housebroken	21.3%	29.0%	–	–	29.7%	19.4%	–	–
Aggressive towards humans	5.5%	14.5%	–	–	15.8%[a]	21.5%	20.6%[b] 15.6%[c]	–
Aggressive towards animals/dogs	8.9%	24.2%	–	16.7%	27.2%	41.4%	–	–
Aggressive behavior (overall)	–	–	–	71.2%[d]	–	–	–	–
Fear/anxiety/phobia	53.4%	32.3%[e]	–	–	28.4[e] 41.4%[f]	51.7%[g] 17.7%[h]		25%[i] 49%[j]
Excessive vocalization	11.3%	25.8%	–	–	18.9%	–	–	–
Pulling on the leash	–	69.4%	–	–	42.5%	–	–	–

* Greyhound adoption program

[a] aggressive behavior when being approached while resting or sleeping in bed

[b] growling or snapping when someone tries to take away food, toys or other objects

[c] biting a family member

[d] lunging, growling, snapping, and/or biting: 40.9%; when barking was included: 71.2%

[e] "generalized fear"

[f] in unfamiliar situations

[g] noise phobia

[h] fear of people

[i] 25% of 4,280 owners reported their dogs as "fearful" in the questionnaires.

[j] 49% of 383 owners said in the interviews that their dog showed at least one fear signal when exposed to noises.

90 laboratory dogs in four research facilities did not react aggressively to intimidating manipulations.

Our study further showed that separation anxiety and lack of housetraining occurred frequently. This result was in concordance with Ake (1996) and Carbone (1997). Of the 39 laboratory dogs examined by Ake (1996), 23.1% were not housebroken after 3 months. In contrast, Aventis Pharma AG (Germany) stated in the LASA report (LASA, 2004) that, according to their experience, problems with housetraining had not occurred and that their laboratory dogs had been housebroken within a few days. This discrepancy is probably due to the housing conditions at Aventis, where dogs had permanent access to outdoor areas, allowing spatial separation of resting and elimination areas. In the present study, the dogs came from a facility in which they had restricted access to outdoor areas, making it difficult to separate resting and elimination areas. Thus, they were used to eliminate indoors. The herein found rate 39% (50 of 126) of dogs that were not completely housebroken within 12 weeks after rehoming is higher than that reported for rehomed shelter dogs (Tab. 6). It is important to note that the applied methods and the definition of "inappropriate elimination" differed among these studies.

Separation-related problems increased over time and can be explained by the bonding that developed between the dogs and their new owners. Although seemingly high, this percentage did not exceed the occurrence of separation anxiety reported for

adopted shelter dogs (Tab. 6). High noise levels due to barking are common in laboratory dog facilities (Sales et al., 1997). However, in our study, excessive barking was not a problem in the new homes. Only 5% of the new owners stated "frequent barking" as a problematic behavior perceived as disturbing. In contrast, vocalization in rehomed shelter dogs has been reported to occur more frequently. The same was true for pulling on the leash, with a higher incidence in rehomed shelter dogs (Tab. 6) than in the laboratory dogs of our study.

The return rate in the present study was 6.2% (9 of 145 dogs, of which 2 were returned due to allergy developed by the owner). This rate is very low compared with those found by Carbone (1997) and Ake (1996) concerning rehomed laboratory dogs, and with those reported for rehomed shelter dogs (LASA, 2004; Diesel et al., 2008; Marston et al., 2005), but is similar to the return rate found by Marston et al. (2004) (7% of n = 4,405 shelter dogs). However, comparison of these return rates is difficult because the studies differed in their methods and time scales. The high success rate of 94% in our study and the high degree of owner satisfaction indicate an excellent selection and preparation of the new owners by the animal welfare organizations.

We examined the possibility to predict certain behaviors or traits in Test 2 based on the initial test in the research facility. Although we found correlations for many of the analyzed parameters, they were only low to moderate and reflect the typically low predictability of behavioral traits in dogs over time (Svartberg, 2005). Dogs change over time because they mature, and factors such as training can influence their behavior (Svartberg, 2005). In addition, dogs' behaviors may differ when a behavior test is repeated because of learning (Diederich and Giffroy, 2006). Furthermore, as shown by Poulsen et al. (2010), Kis et al. (2014) and Mornement et al. (2014, 2015), behavior tests have only poor predictive validity when conducted with shelter dogs. Such low correlations are explicable, because adopted shelter dogs experience a new life situation with various influences of new conditions and owners. The same applies to rehomed laboratory dogs. Low correlations indicate that the dogs can adapt to the new situation. Higher correlations may be expected in adult dogs, in dogs held under constant conditions, and when the tests are conducted within relatively short time intervals, as found in a study by Svartberg et al. (2005).

Although the correlations found in our study were only low to moderate, the significant disposition effects observed from Test 1 to Test 2 and Interview 1 to Interview 2 indicate individually consistent behavior in the laboratory dogs. Svartberg (2005) found the most consistent behavior inter alia in the trait sociability towards strangers. We also found the greatest consistency in the behavior towards strangers (test part "contact"), especially in dogs ≥ 2 years old.

Our finding that the dogs' behavior during isolation in the research facility did not correlate with the separation-related problems after adoption could indicate that the dogs experienced the isolation differently before and after adoption. Likely, the social bonding with the new owner led to the development of these problems.

The results from our statistical analyses do not support the claim by LASA (2004) that juvenile dogs adapt better to their new homes than older dogs. On the contrary, the juvenile dogs in our study were the most likely to show problematic behaviors such as separation anxiety and not being housebroken. Dogs of 1.5-2.5 years scored significantly lower in Test 1 than younger and older dogs. Dogs generally become socially mature and change their behavior at approximately 2 years (Overall and Love, 2001; Overall, 2013). Behavioral problems like aggression, general anxiety and fear become most apparent in this phase of social maturity (Overall and Love, 2001; Horwitz and Neilson, 2007; Overall, 2013) and are the reason why many dogs of that age are presented to animal behavior clinics (median age: 2.5 years; Bamberger and Houpt, 2006).

In line with previous results (Döring et al., 2014, 2016), we showed that dogs that had been purchased from commercial breeders scored significantly lower than dogs that had been born in the research facility. This result was due to the low scores of the dogs from the German breeders, whereas the dogs from the U.S. and the Italian breeder received high scores.

In contrast to the assumptions made in the LASA report (2004), we found neither an indication of adaptation problems related to the presence of children nor positive effects of another dog in the household. For adopted shelter dogs, Diesel et al. (2008) reported that families with children were more likely to return the dog to the shelter than owners without children. The difference between shelter und laboratory dogs may be that laboratory beagles are particularly tolerant and rarely show aggressive behavior.

The new owners mostly conducted obedience training, frequently used rewards and almost never applied physical punishment. These results indicate that the new owners had been selected carefully by the rehoming organizations. For comparison, Hiby et al. (2004) found that 12% of 364 dog owners used physical punishment.

In contrast to previous findings (e.g., Bennett and Rohlf, 2007; Kubinyi et al., 2009), we did not find evidence that the owners' previous experience in owning a dog influenced the dogs' behavior. Hence, it would not be justified to place laboratory beagles only with experienced dog owners. However, we recommend a careful selection and preparation of new owners (see also LASA, 2004).

5 Conclusions

The adopted laboratory beagles showed a significant change toward desired behavior within 6-12 weeks and thus proved to be exceptionally adaptable. Altogether, the incidence of behavior problems was comparable with that of adopted shelter dogs examined in other studies. The initial behavior test had only low to moderate predictive power. Nevertheless, significant disposition effects were found in both the behavior tests and the interviews. The age of the dogs had a significant influence on their behavior, whereas the origin of the dogs had a significant influence on their development. Furthermore, the new owners were very satisfied. Thus, the following recommendations can be made:
1. The rehoming of laboratory dogs presents a valuable alternative to euthanasia.

2. It is not restricted to only young dogs.
3. It is not restricted to experienced dog owners.
4. The rehoming process relies on the animal welfare organizations which carefully select and prepare the new owners.

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Conflict of interest

The authors state no conflict of interest.

Acknowledgments

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