Department of Physics, Chemistry and Biology

Master Thesis

The effects of recent selection on behaviour in two breed lines of Labrador retriever

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Sammanfattning/Abstract:

During the last decades the Labrador retriever has diverged into two types, the common type and the field type. The common type is mostly seen in dog shows or used as a family dog while the field type is mostly used as a gundog. The aim of the present study was to examine the effects of recent selection by assessing whether these two breed lines differ in behaviour. If behavioural differences exist, the recent common gene-pool simplifies studying which genes are associated with the behavioural differences between the breed lines. 101 privately owned Labrador retrievers were filmed doing a behaviour and personality test for dogs. Of the 101 dog owners, 97 also answered a questionnaire. Results show that common-type Labrador retrievers are more interested in meeting and greeting strangers compared to the field type that show more aggression and fear towards strangers. The common type showed less non-social fear and was more prone to chasing while the field type had higher trainability. Further, the results indicate that there may be a relationship between non-social fear and chase-proneness as well as a relationship between non-social fear and trainability in the Labrador retriever. These behavioural differences between the two breed lines suggest that recent selection can have large effects on dog behaviour and could indicate genetic differences. These two breed lines of Labrador retriever appear to be good candidates for finding the genes underlying the behavioural differences found in the present study.

Nyckelord/Keyword:
BPD, BPH, canine, common type, dog, field type, gundog, show

Content

1 Abstract

During the last decades the Labrador retriever has diverged into two types, the common type and the field type. The common type is mostly seen in dog shows or used as a family dog while the field type is mostly used as a gundog. The aim of the present study was to examine the effects of recent selection by assessing whether these two breed lines differ in behaviour. If behavioural differences exist, the recent common gene-pool simplifies studying which genes are associated with the behavioural differences between the breed lines. 101 privately owned Labrador retrievers were filmed doing a behaviour and personality test for dogs. Of the 101 dog owners, 97 also answered a questionnaire. Results show that common-type Labrador retrievers are more interested in meeting and greeting strangers compared to the field type that show more aggression and fear towards strangers. The common type showed less non-social fear and was more prone to chasing while the field type had higher trainability. Further, the results indicate that there may be a relationship between non-social fear and chase-proneness as well as a relationship between non-social fear and trainability in the Labrador retriever. These behavioural differences between the two breed lines suggest that recent selection can have large effects on dog behaviour and could indicate genetic differences. These two breed lines of Labrador retriever appear to be good candidates for finding the genes underlying the behavioural differences found in the present study.

2 Introduction

Domestication of the dog likely started 18 800 to 32 100 years ago in Europe (Thalmann et al., 2013) and the first distinctive breeds seem to appear around 3000 to 4000 years ago (Brewer et al., 2002), but it was during the Middle Ages that the number of breeds really increased (Clutton-Brock, 1995). Today more than 1000 dog breeds exist worldwide (Morris, 2008) and about 200 are recognized by national and international kennel clubs (Mehrkam and Wynne, 2014). It has been suggested that selection during the breeds' origin have caused the observed breed differences in behaviour (Scott, 1964). Historically, dog breeds were typically selected for traits that made them suitable for tasks such as guarding, herding and hunting and some studies indicate that these traits are still present in the breeds today (Mahut, 1958; Bradshaw et al., 1996). While it may be true that some breeds have older origins, the majority of the modern breeds were created during the last 150 years and has little genetic resemblance with more ancient breeds (Larson et al., 2012). Further, recent historical records have shown that a majority of the modern breeds have had significant population fluctuations the last 100

years (Larson et al., 2012). Therefore, the term "breed" seems best applied to modern breeds recognized by kennel clubs rather than more historical divisions.

It has been shown that dog breeds differ in morphology (Wayne, 1986), genetics (Wayne and Ostrander, 1999) and behaviour (Scott, 1964). While Scott's (1964) experiments provided evidence of breed differences in barking several decades ago, more recent studies have shown breed differences in behaviours such as aggressiveness, curiosity/fearlessness, playfulness, sociability and trainability (Svartberg, 2006; Duffy et al., 2008; Turcsán et al., 2011). Interestingly, grouping breeds by behavioural similarity has shown poor congruence with both functionally (herding, working, etc.) and genetically based groups (Svartberg, 2006; Turcsán et al., 2011; Mehrkam and Wynne, 2014). This may indicate the influence of recent selection (Turcsán et al., 2011) and is supported by the results of Svartberg (2006) which suggest that it is in fact selection during the recent past that has resulted in the breed differences we see today. These results indicate that the dominating selection pressure today is breeding for dog shows and that show dogs in general are lower in aggression, curiosity and playfulness, and higher in fearfulness (Svartberg, 2006). Selection for use as a working dog, on the other hand, has been positively correlated with aggression and playfulness (Svartberg, 2006). While Svartberg (2006) measured behavioural inter-breed differences, a study by Duffy et al. (2008) also presented results from within-breed differences. These results indicate a more complex relationship between show dogs and working dogs since Labrador retrievers bred for field work exhibited more owner-directed aggression than Labrador retrievers bred for show, but English springer spaniels bred for field work exhibited less stranger-directed aggression, owner-directed aggression and dog-directed aggression compared to English springer spaniels bred for show (Duffy et al., 2008). This suggests that breeding for show or for field work may have different effects on behaviour in different breeds. However, it is hard to draw any conclusions since the available data is very limited. While there are quite a few behavioural studies on breed differences, studies on within-breed differences remain scarce.

The large number of different breeds in combination with strict breed standards has made the dog very well suited for research in behavioural genetics. Identifying the genes controlling different behaviours could be a big help when trying to breed dogs for different roles in our society but could also benefit research on behavioural diseases in humans. When trying to find the genes underlying different behaviours it is easier to compare dog breeds than to compare different species. Because dog

breeds have a more recent common origin they also have more genes in common. This should simplify the process of finding the genes behind breed-typical characteristics since the gene pool of possible candidates controlling a characteristic is smaller. However, while the genetics of canine inherited diseases have seen much progress, the same cannot be said for behavioural genetics (Van Rooy, 2014). One difficulty is that behaviours seldom seem to follow a Mendelian mode of inheritance but rather a more complex one (Van Rooy, 2014), making the genes underlying a behaviour harder to find. Finding the genes controlling a polygenic trait, where each gene might show a very small change in expression, is more difficult than finding one gene with a big change in gene expression. Another issue in this research field is interactions between behaviours. For instance, a link between anxiety disorders and aggression disorders has been shown (Bamberger and Houpt, 2006). This means that a gene that seems to control aggression could actually be controlling anxiety.

Another problem in behavioural genetics is how to actually measure the behaviours, preferably in a standardised way, so that results can be compared across studies. There are basically two ways of measuring behaviour in dogs. The first is by means of a behavioural test in which the dog is presented with a situation and its behaviour is recorded. The second is by using a questionnaire where the dog's owner answers questions about their dog's behaviour in everyday life. The biggest issue concerning behavioural tests seems to be the lack of standardisation. A review of the testing methodology used in over 30 studies found that the test setup was often unique for each researcher (Diederich and Giffroy, 2006). However, there are standardised tests available like the dog mentality assessment (DMA) and the behaviour and personality test for dogs (BPD) which are Swedish tests used to test thousands of dogs each year. Besides a lack of standardisation, behavioural tests are often very time-consuming and they usually only measure the behaviours during a single trial. Owner-based questionnaires, on the other hand, can take several situations into account when assessing a behaviour. Also, the dog's behaviour is assessed based on events in its normal life rather than a constructed test situation. But arguably most important is that a questionnaire is relatively cheap and facilitates large sample sizes. However, owner-based questionnaires can suffer from poor objectivity and reliability since it is the dog's owner that assesses its behaviour and different owners might interpret the questions in different ways. One questionnaire that has been validated (Hsu and Serpell, 2003) is the Canine behavioural assessment and research questionnaire (C-BARQ),

which has been used in several studies (Svartberg, 2005; Duffy et al., 2008; Lofgren et al., 2014).

As stated earlier, when trying to find the genes underlying different behaviours, it is easier to compare dog breeds rather than different species as they have more genes in common. Similarly, it is easier to compare two types of the same breed rather than different breeds as they have even more genes in common. Researchers and Labrador retriever breeders recognize that Labrador retrievers can be divided into a common type and a field type. As some breeders began focusing on behaviours suitable for field work instead of breeding for dog shows, the Labrador retriever started to diverge into two types. One is usually referred to as conformational, show or common type and the other as field or working type (Duffy et al., 2008; Craig, 2011). The common type is mostly seen in dog shows or used as a family dog, while the field type is mostly used as a gundog. The Labrador retriever may have been bred for as much as 200 years and has historically been used as a hunting dog that retrieved killed prey for the hunter (Swedish Kennel Club, 2015). Today the breed also fills other roles like companion, show, or service dog. Labrador retrievers have been found to be a quite fearless breed. Blackwell et al. (2013) reported that Labrador retrievers were less likely to show fear responses to loud sounds compared to other breeds and Goddard and Beilharz (1985) found Labrador retrievers to be the least fearful in startling tests compared to German Shepherds, boxers and kelpies. This fearlessness may be due to the Labrador retriever's history as a gundog where this would have been a desirable trait. Another factor connected to behaviour is coat colour. A yellow coat colour has been correlated to problem behaviours in Labrador retrievers (Kobelt et al., 2007). Similar results have been found in English cocker spaniels, where individuals with a red/gold coat colour were more likely to show aggression than black individuals across a range of situations (Podberscek and Serpell, 1996). This division in two breed lines can also be seen in the Swedish Labrador retriever population, which has to some extent been bred in two separate lines the last decades. This relatively recent split into two breed lines makes the Labrador retriever a good candidate for studying the effects of recent selection on behaviour. As dog shows and field work present very dissimilar environments, where different behaviours are desired, it is likely that differing selection pressures have led to two genetically different breed lines.

The aim of the present study was to examine the effects of recent selection by assessing whether two breed lines of Labrador retriever, one bred as a show and family dog and the other for field work, differ in

behaviour using a standardised behavioural test and a questionnaire. If behavioural differences exist, the recent common gene-pool simplifies studying which genes are associated with the behavioural differences between the breed lines. Based on previous studies by Svartberg (2006) and Duffy et al. (2008) predictions are that recent selection have resulted in behavioural differences where common-type Labrador retrievers should show more fearfulness while field-type Labrador retrievers show more aggression and playfulness.

3 Material & methods

3.1 Animals

The dogs in this study were 101 privately owned Labrador retrievers of ages ranging from one to four years. Test participants were recruited via dog clubs and social media, where they could express their interest in participating via a form. The dogs were selected to be as young as possible to minimise the influence of training, but all dogs were at least twelve months of age which was a requirement of the behavioural test. The dogs were from two breed lines (i.e. types) called common type and field type. To be classified as a field-type Labrador retriever, the dog's closest ancestors had to contain at least three generations of field-bred dogs. This was established by field-trial titles in and beyond the three generations. Dogs were classified as common-type Labrador retrievers if they had pedigrees where none of the ancestors three generations back were field bred. Pedigrees were found in the registry of the Swedish Kennel Club (Hunddata, 2014) and the database k9data.com (2014) which contains data from several registries. From the dog owners who had expressed an interest in participating, a selection was made to get a sample with an even distribution of type and sex (Table 1).

Table 1. Distribution of type, sex and mean age of the participating Labrador retrievers.

	Common type		*Field type*		*Total*	
	N	*Mean age ± SE (years)*	*N*	*Mean age ± SE (days)*	*N*	*Mean age ± SE (days)*
Males	24	1.8 ± 0.1	24	2.0 ± 0.2	48	1.9 ± 0.2
Females	28	1.8 ± 0.1	25	2.1 ± 0.1	53	1.9 ± 0.1
Total	52	1.8 ± 0.1	49	2.0 ± 0.1	101	1.9 ± 0.1

3.2 The behaviour and personality test for dogs

BPD stands for 'behaviour and personality test for dogs' and was developed by the Swedish Kennel Club. The BPD is a standardised test battery designed to describe a dog's mentality with focus on sociality, play interest, food interest, contact with owner, curiosity, fear/insecurity and threat/aggressiveness. The test was developed as a tool for both breeders and dog owners and can be used to assess a dog's suitability as a family dog, working dog or breeding stock. The BPD consists of eight subtests which include meeting unfamiliar people, playing, searching for food, getting surprised and hearing a gunshot, among others. The subtests are shortly described below (Table 2, Figure 1). A full description in Swedish can be found at the Swedish Kennel Club website (Swedish Kennel Club, 2015). During the test, the dog is led by its owner. A test leader accompanies the pair through the test and instructs the owner when necessary. Each subtest is scored by an authorized observer using a standardised scoring sheet which is available in the appendix (Table A2). For each subtest, the observer scores a number of predefined variables using a scale ranging from zero to four. A low number means a low intensity or low occurrence of the behaviour and a higher number means a higher intensity or higher occurrence of the behaviour. The behavioural data from the scoring was provided by the Swedish Kennel Club.

Table 2. Short descriptions of the eight subtests of the behaviour and personality test for dogs.

Subtest	*Description*
Strange person	A person unfamiliar to the dog approaches the dog and its owner, handles the dog and takes it for a short walk.
Play	The dog is invited to play with both a familiar and an unfamiliar toy and to a tug-of-war with the test leader.
Food interest	The dog is presented with an unsolvable problem baited with food.
Visual startle	A figure resembling a human upper body pops up 3 meters in front of the approaching dog.
Rattle	A loud rattling noise is emitted 3 meters in front of the approaching dog.
Approaching person	A figurant dressed in a long coat, broad-brimmed hat and sun glasses slowly approaches the dog.
Unfamiliar surface	Dog and owner walk together over a surface of corrugated plastic.
Gunshot	Two gunshots are fired. One when the dog is walking and one when the dog is sitting.

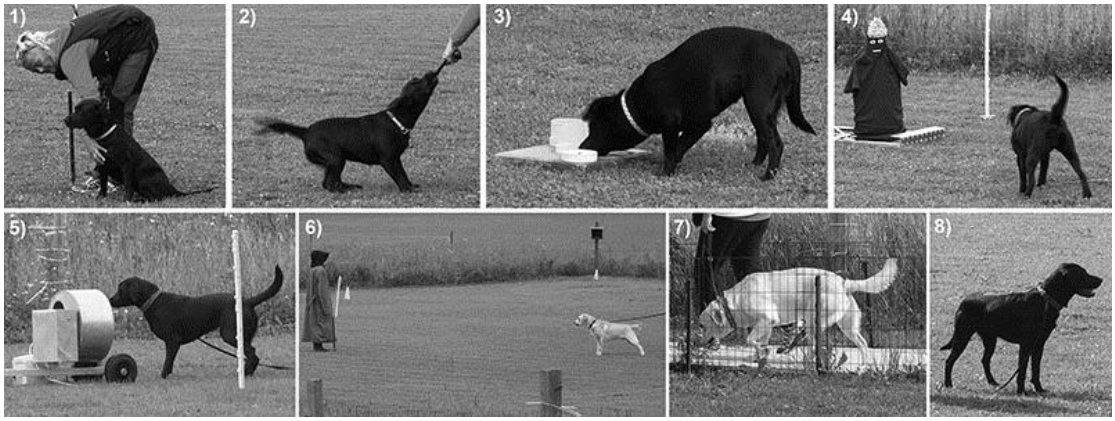

Figure 1. The eight subtests of the behaviour and personality test for dogs. 1) Strange person, 2) Play, 3) Food interest, 4) Visual startle, 5) Rattle, 6) Approaching person, 7) Unfamiliar surface, 8) Gunshot (Table 2).

3.3 Detailed behavioural scoring

In addition to the scoring done by the authorised observer during the BPD, all dogs were filmed performing the test using a Sony digital video camera. Because of time constraints, only segments of the subtests 'strange person', 'visual startle' and 'approaching person' were analysed using continuous observation in Noldus Observer XT 10. These three subtests were chosen because I thought the greatest differences between the two types of Labrador retriever could be seen in these subtests. Table 3 describes the segments that were observed. Behaviours were scored using an ethogram which included body posture, tail position, tail movement, reaction to the stimulus, stress indicators and vocalisations. The full ethogram can be found in the appendix (Table A1). These behaviours were scored in order to evaluate the dogs' reactions in the different situations presented by the BPD. Most behaviours were recorded as the amount of time the behaviour was performed. A few behaviours with very short durations, like a bark, were recorded as the number of times the behaviour was performed.

Table 3. The segments of the behaviour and personality test for dogs that was scored in detail using the recorded videos.

Segment	*Description*
Strange person 1	The test leader approaches dog and owner and takes a position next to the owner.
Strange person 2	The test leader greets the dog.
Strange person 3	The test leader talks to the owner.
Visual startle 1	The visual startle pops up. Owner and test leader stand still and passive.
Visual startle 2	Owner and test leader approach the startle and sit down in front of it.

Segment	*Description*
Visual startle 3	Dog and owner walk past the startle to make sure the dog no longer reacts to it.
Approaching person 1	The dog is leashed. The figurant approaches and turns around standing still with the back towards the dog.
Approaching person 2	The leash is released and the dog can make contact with the figurant.
Approaching person 3	The dog has made contact with the figurant.
Approaching person 4	The figurant has removed the coat, hat and sunglasses. He/she sits down and calls for the dog.

3.4 The questionnaire

All dog owners participating in the BPD were asked to fill out a questionnaire based on the Canine behavioural assessment and research questionnaire (C-BARQ), which was developed and validated by Hsu and Serpell (2003). The C-BARQ contained 111 questions about the dog's reactions in different situations and these questions can be divided into eleven categories (Hsu and Serpell, 2003). The C-BARQ used in the present study has been modified since Hsu and Serpell (2003) and now also includes the category 'dog rivalry'. It was previously translated to Swedish and used by Kenth Svartberg (Svartberg, 2005). An additional 40 questions were added to the questionnaire regarding training ambitions and training habits among other things. Of the 101 participants, 97 answered the C-BARQ.

3.5 Data analyses

3.5.1 Data analyses: Behaviour and personality test for dogs

The BPD behavioural scores provided by the Swedish Kennel Club were condensed into 32 behaviours using the same method the Swedish Kennel Club uses to present the BPD scores on their website (Table 4). Basically, the scores for a behaviour are averaged for each subtest but for some variables the behavioural scores of several subtests are averaged. The formulas for calculating these 32 behaviours are available in the appendix (Table A3).

Table 4. The 32 condensed behaviours from the behaviour and personality test for dogs.

Subtest	*Behaviour*
Strange person	Greeting of strange person (intensity)
	Greeting of strange person (time)
	Worry of strange person
	Avoidance of strange person
	Separation anxiety during walk with strange person
	Threatening behaviour towards strange person
Play	Play interest with familiar toy
	Play interest with new toy
	Interest in tug-of-war
	Interest in playing with the owner
Food interest	Interest in food
	Contact at food
Visual startle	Offensive reaction at startle
	Threatening behaviour at startle
	Worry at startle
	Escape at startle
	Curiosity at startle
Rattle	Worry at rattle
	Escape at rattle
	Curiosity at rattle
Approaching person	Threatening behaviour towards the approaching person
	Avoidance of the approaching person
	Worry of the approaching person
	Greeting of the approaching person (intensity)
	Greeting of the approaching person (time)
Unfamiliar surface	Insecurity on unfamiliar surface
Gunshot	Gunshot insecurity
	Gunshot activity
General behaviours	Submissiveness
	Impressive posturing
	Exploration of things other than the stimulus
	Bite or bite attempt towards figurant

3.5.2 Data analyses: Detailed behavioural scoring

Behaviours that were recorded as the amount of time the behaviour was performed were divided by the total time of the observed segment. This yielded the behaviour as a percentage of the time it was performed. Behaviours that were recorded as the number of times the behaviour was performed were divided by the total time of the observed segment. This yielded the behaviour as a ratio. Thereafter, the scores were averaged for each dog. For the subtests 'Strange person' and 'Approaching person' the scores from each segment were averaged. For the subtest 'Visual startle', segment one and segment two were averaged while segment three was analysed separately. The 'Visual startle' segments were divided this way because segment one and two presents a very different situation compared to segment three.

3.5.3 Data analyses: Questionnaire

The 111 C-BARQ questions about the dog's reactions in different situations were divided into twelve categories called: 'stranger-directed aggression', 'owner-directed aggression', 'stranger-directed fear', 'non-social fear', 'dog-directed fear or aggression', 'separation-related behaviour', 'attachment or attention-seeking behaviour', 'trainability', 'chasing', 'excitability', 'dog rivalry' and 'pain sensitivity'. The C-BARQ questions were transformed into these categories by averaging specific questionnaire items using the standardised method described in the appendix (Table A4).

3.5.4 Reduction of behaviours into components

Principal component analysis (PCA) was used to analyse both the 32 condensed behavioural scores from the BPD and the detailed behavioural scores from the video analyses. For the BPD scores, one PCA was performed to reduce the 32 variables. For the detailed behavioural scores, a total of four PCAs were done; one for 'Strange person', one for 'Visual startle' segment one and two, one for 'Visual startle' segment three, and lastly, one for 'Approaching person'.

PCA is a statistical method that reduces a number of correlated variables into a number of uncorrelated components. The standard procedure in many statistical programs is to retain all components with an eigenvalue greater than 1.0 even though this is considered one of the least accurate methods (Osborne and Costello, 2009). A better way to determine the number of retained components is using the scree test (Osborne and Costello, 2009). In the present study, the scree test was used as a

guideline, but the actual number of retained components can vary slightly to improve interpretability and loading of the components, as recommended by Osborne and Costello (2009). The component matrix was rotated using a varimax rotation to simplify the data structure. Components were named with regard to the strongest loading variables. Component scores for each individual were calculated as standardized regression scores (Mean = 0, SD = 1) by the PCA.

3.5.5 Effects of type of Labrador retriever, sex and age

General linear models (GLM) were used to evaluate the effects of type of Labrador retriever as well as age and sex on the components obtained from the five PCAs and the categories obtained from the C-BARQ. A univariate model was used where type, age and sex were added as fixed factors. All interactions between these factors were tested and the model was then reduced by repeatedly eliminating the least significant interaction, one at the time, until no interactions or only significant interactions remained. Dogs were categorised as 'young' if they were less than 548 days and 'old' otherwise to get an even distribution of 'young' and 'old' dogs. This categorisation was done to more easily be able to relate to and discuss the data. Results are presented as mean ± SE. IBM SPSS Statistics 22 was used for all statistical analysis and the significance level was set to $P < 0.05$.

4 Results

4.1 Differences between common-type and field-type Labrador retrievers in the behaviour and personality test for dogs

The behaviours 'threatening behaviour towards strange person', 'play interest familiar toy', 'play interest new toy', 'avoidance strange person', 'escape at rattle' and 'bite or bite attempt towards figurant' were not included in the PCA due to zero or very low variance. From the PCA on 26 of the remaining variables, five components were retained (Table 5). The first component mainly has strong loadings on behaviours related to greeting and interacting with strangers and was therefore labelled 'interest in strangers'. The second component was mostly related to the visual startle and is labelled 'non-social fear'. The third component was mostly related to worry but not escape and threatening behaviour and was therefore labelled 'passive fear'. The fourth component was mostly related to fear towards strangers and was labelled 'social fear'. The last component was simply labelled 'component 5' as it was hard to interpret. Total variance explained by the five components is 48.7%.

Table 5. Rotated component matrix from the Principal component analysis performed on 26 of the 32 behaviours from the behaviour and personality test for dogs, which the Labrador retrievers participated in. The table displays the loadings of each variable on the extracted components. Loadings of more than 0.4 are shown in bold. Sampling adequacy: Bartlett´s sphericity test χ^2 = 938.913, df = 325, P < 0.001; KMO: 0.606

	Component				
	Interest in strangers	Non-social fear	Passive fear	Social fear	Component 5
Greeting of strange person (intensity)	**0.81**	-0.18	0.09	0.10	0.01
Greeting of strange person (time)	**0.81**	-0.16	0.07	0.05	-0.04
Greeting of approaching person (intensity)	**0.81**	0.13	-0.12	-0.12	0.04
Greeting of approaching person (time)	**0.78**	0.09	-0.22	-0.17	0.05
Worry strange person	**-0.54**	-0.11	-0.08	0.25	0.32
Interest in tug-of-war	0.31	-0.01	-0.17	0.15	0.09
Escape at startle	-0.05	**0.83**	0.29	0.12	0.11
Curiosity at startle	-0.02	**-0.82**	-0.20	0.16	0.04
Threatening behaviour at startle	-0.04	**0.75**	-0.08	0.05	-0.13
Interest in playing with owner	0.04	**0.43**	0.06	0.00	0.34
Gunshot insecurity	0.05	0.26	0.11	0.21	-0.03
Worry at rattle	-0.17	0.27	**0.76**	0.02	0.09
Worry approaching person	-0.21	-0.10	**0.65**	**0.42**	0.04
Worry at startle	-0.01	0.26	**0.63**	0.02	0.12
Curiosity at rattle	0.01	-0.23	**-0.49**	0.13	-0.29
Impressive posturing	0.08	-0.26	**0.41**	0.31	-0.24
Offensive reaction at startle	-0.29	-0.08	-0.32	0.21	0.05
Exploration of things other than the stimulus	0.15	-0.24	0.26	-0.25	0.24
Threatening behaviour towards the approaching person	0.09	0.07	0.05	**0.71**	-0.19
Avoidance approaching person	-0.28	-0.05	-0.03	**0.68**	0.25
Separation anxiety during walk with strange person	-0.22	0.02	0.20	**0.52**	0.16
Interest in food	0.21	0.14	-0.27	**0.48**	0.10
Gunshot activity	0.11	-0.08	0.01	0.25	**0.62**
Contact at food	-0.12	-0.06	0.20	-0.07	**0.60**
Submissiveness	-0.23	0.06	-0.25	0.16	**0.59**
Insecurity on unfamiliar surface	0.13	0.07	0.14	-0.07	**0.47**
Proportion of explained variation (%)	13.2	10.2	9.4	8.4	7.5

There was an effect of type on three of the five components from the BPD. Common-type Labrador retrievers showed more interest in strangers than the field type (common type: 0.40 ± 0.13; field type: -0.47 ± 0.14; $F_{1,92} = 20.87$; $P < 0.01$) but showed less non-social fear than the field type (common type: -0.21 ± 0.14; field type: 0.30 ± 0.15; $F_{1,92} = 6.33$; $P < 0.05$, Figure 2). The components 'passive fear' and 'social fear' did not differ between types. There was, however, a significant difference between the types in 'component 5' (common type: -0.30 ± 0.14; field type: 0.31 ± 0.15; $F_{1,92} = 9.58$; $P < 0.01$, Figure 2). Age and sex had no effect on the five components from the BPD.

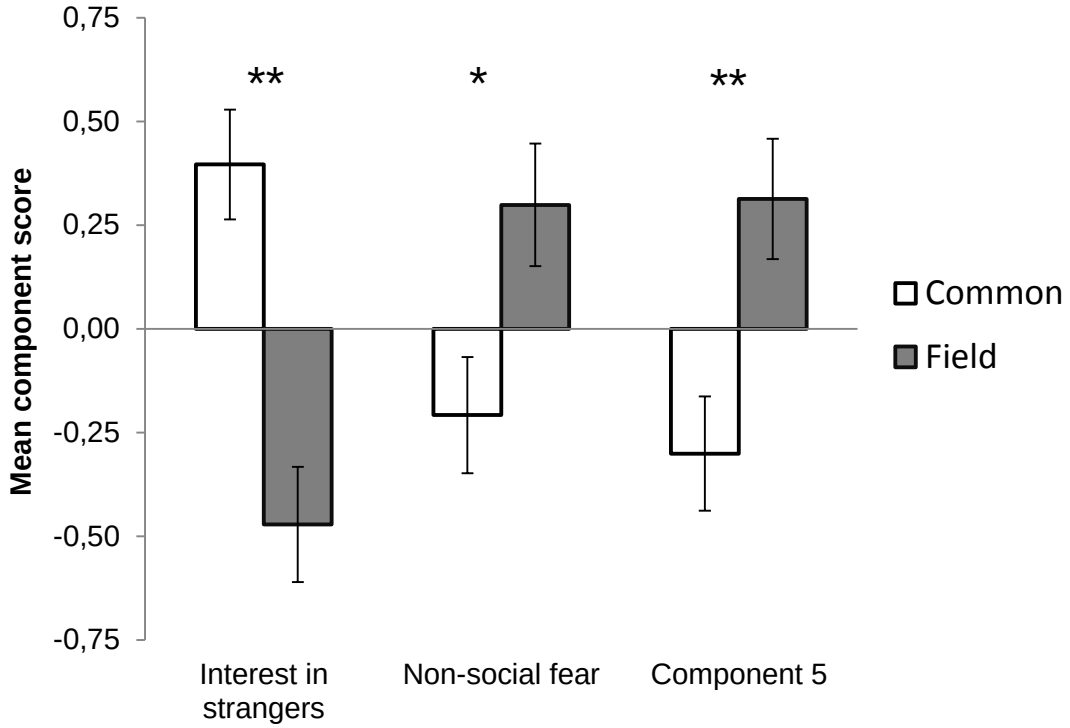

Figure 2. Mean component scores from the principal component analysis of the behaviour and personality test for dogs comparing common-type and field-type Labrador retrievers. Error bars show standard error.

4.2 Differences between common-type and field-type Labrador retrievers in the detailed behavioural scoring

4.2.1 Strange person subtest

Three components were extracted from the PCA performed on the behaviours observed in the 'strange person' subtest (Table 6). The first component was labelled 'disinterest' as contact behaviours had negative loadings and 'sniffing the ground' had a moderate loading. The second component had strong loadings on behaviours indicating a calm dog that takes contact with the test leader and was labelled 'comfortable'. The

third component was labelled ‘uncomfortable’ as the strongly loading behaviours indicated fear or unease towards the test leader. Total variance explained by the three components was 42.1%.

Table 6. Rotated component matrix from the Principal component analysis performed on behaviours from the ‘strange person’ subtest of the behaviour and personality test for dogs, which the Labrador retrievers participated in. The table displays the loadings of each variable on the extracted components. Loadings of more than 0.4 are shown in bold. Sampling adequacy: Bartlett´s sphericity test χ^2 = 471.537, df = 105, P < 0.01; KMO: 0.336

	Component		
	Disinterest	Comfortable	Uncomfortable
No tail movement	**0.87**	0.13	-0.10
Low tail position	**0.67**	-0.18	-0.02
Jumping on strange person	**-0.67**	-0.12	-0.09
Lying down	0.33	0.05	0.21
Low body posture	0.24	-0.13	0.03
Looking at strange person	0.07	**0.73**	0.08
Sitting	0.28	**0.71**	-0.13
Sniffing the ground	**0.41**	**-0.70**	-0.23
High tail position	-0.18	0.35	0.02
Looking at owner	0.08	0.34	0.25
Contact with strange person	-0.18	0.33	-0.25
Whining	-0.04	-0.13	**0.84**
Circling around stimulus	-0.08	-0.12	**0.83**
Looking away from strange person	0.09	0.31	**0.48**
Stress indicators	0.11	0.17	0.36
Proportion of explained variation %	14.5	14.2	13.4

There were no significant differences comparing type, sex or age for the components from the principal component analysis performed on the ‘strange person’ subtest. However, there was a tendency indicating that the common-type Labrador retrievers showed less disinterest towards a strange person than the field type (common type: -0.19 ± 0.14; field type: 0.20 ± 0.15; $F_{1,91} = 3.66$; P = 0.059).

4.2.2 Visual startle subtest: segment one and two

Three components were extracted from the PCA performed on the behaviours observed in the ‘visual startle’ subtest segment one and two

(Table 7). The first component was labelled ‘active fear’ as it was related to a very high body posture, a high tail, raised hackles and lots of vocalisation and movement. It was also related to a high latency to take contact with the visual startle. Component two was also related to a high latency to take contact with the visual startle but had strong loadings on behaviours such as a low still tail, standing still and looking away from the visual startle. Component two was therefore labelled ‘passive fear’. Component three was labelled ‘nervousness’ as a low body and low tail indicated some fear. However, it seemed to be a weaker fear response since there was no strong loading on ‘latency to contact with visual startle’ and a moderate loading on ‘sniffing the visual startle’. Total variance explained by the three components was 44.1%.

Table 7. Rotated component matrix from the Principal component analysis performed on behaviours from the ‘visual startle’ subtest segment one and two, which the Labrador retrievers participated in. The table displays the loadings of each variable on the extracted components. Loadings of more than 0.4 are shown in bold. Sampling adequacy: Bartlett´s sphericity test χ^2 = 1071.812, df = 253, P < 0.01; KMO: 0.514

	Component		
	Active fear	Passive fear	Nervousness
Hackles raised	**0.81**	0.01	0.01
Latency to contact with visual startle	**0.75**	**0.51**	-0.03
Circling	**0.73**	-0.08	0.05
Very high body posture	**0.73**	-0.07	-0.26
Barking	**0.70**	-0.34	0.02
Growling	**0.63**	-0.06	-0.12
Approaching	**-0.56**	-0.27	0.07
Withdrawal	**0.53**	-0.10	0.27
Looking at owner	**-0.46**	0.07	-0.38
High body posture	0.36	-0.02	-0.05
Interaction with viewers	0.29	0.13	-0.18
No tail movement	0.01	**0.77**	0.26
Standing still	-0.13	**0.67**	-0.05
Fast tail movement	0.21	**-0.60**	0.23
Look away from visual startle	-0.12	**0.52**	0.04
Physical contact with visual startle	**-0.42**	**-0.51**	0.07
Jumping	-0.18	-0.30	0.11
Low tail position	0.21	**0.57**	**0.71**
Low body posture	0.04	-0.06	**0.71**
High tail position	**0.40**	-0.27	**-0.54**

	Component		
	Active fear	Passive fear	Nervousness
Staying away	**0.42**	0.16	**-0.46**
Sniffing the visual startle	-0.12	-0.11	**0.44**
Support seeking	0.02	0.28	0.30
Proportion of explained variation %	21.0	13.1	10.0

The component 'Nervousness' showed a significant difference between the two types of Labrador retriever (common type: -0.31 ± 0.13; field type: 0.56 ± 0.15; $F_{1,87} = 19.03$; $P < 0.01$, Figure 3). 'Nervousness' also showed a significant sex difference (males: -0.25 ± 0.14; females: 0.50 ± 0.15; $F_{1,87} = 14.10$; $P < 0.01$). The components 'Active fear' and 'Passive fear' did not reveal any significant differences when comparing type, sex or age.

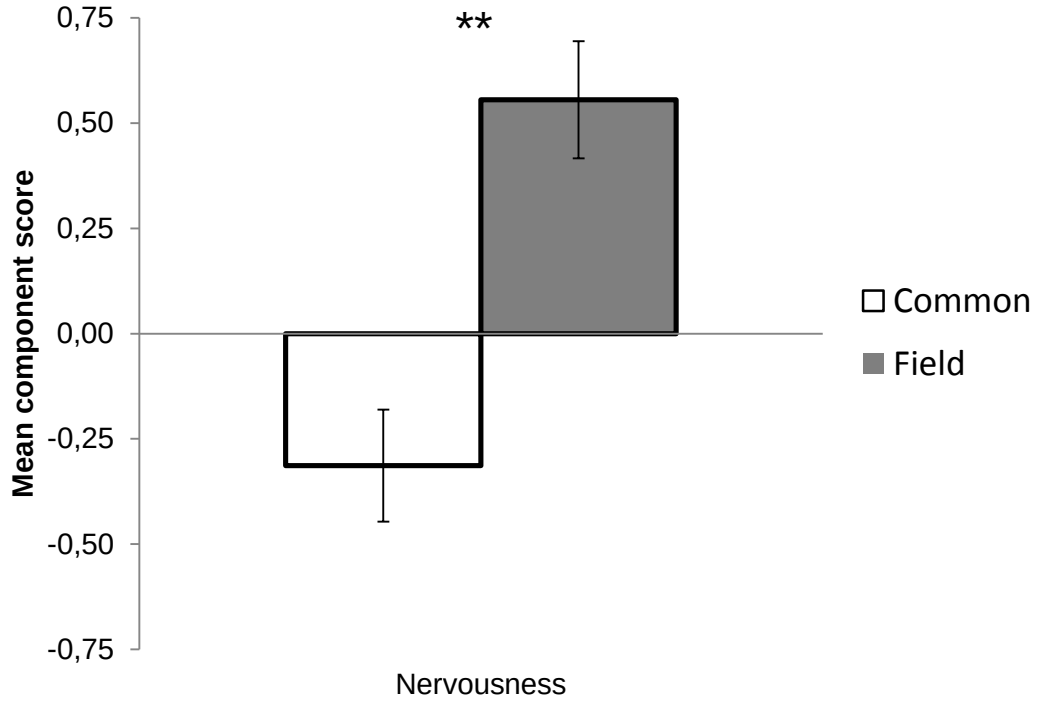

Figure 3. Differences in the component 'nervousness' from the principal component analysis of the 'visual startle' subtest segment one and two comparing common-type and field-type Labrador retrievers. Error bars show standard error.

4.2.3 Visual startle subtest: segment three

Three components were extracted from the PCA performed on the behaviours observed in the 'visual startle' subtest segment three (Table

8). The first component had strong loadings on behaviours indicating fear but also on 'withdrawal' and was therefore labelled 'fear avoidance'. The second component had strong loadings on threatening behaviours such as raised hackles and barking and was labelled 'active fear'. The third component was labelled 'fear support' as it had strong loadings on 'circling', 'growling' and 'looking at owner' which indicates the dog is still nervous about the startle and looks at the owner for support. Total variance explained by the three components was 40.2%.

Table 8. Rotated component matrix from the principal component analysis performed on behaviours from the 'visual startle' subtest segment three, which the Labrador retrievers participated in. The table displays the loadings of each variable on the extracted components. Loadings of more than 0.4 are shown in bold. Sampling adequacy: Bartlett´s sphericity test χ^2 = 815.819, df = 136, P < 0.01; KMO: 0.185

	Component		
	Fear avoidance	Active fear	Fear support
Low body posture	**0.88**	0.04	0.01
Withdrawal	**0.78**	0.02	0.23
Puffing	**0.68**	-0.06	0.11
Low tail position	**0.61**	-0.06	-0.12
No tail movement	**0.42**	0.06	-0.12
Barking	0.04	**0.80**	-0.15
Hackles raised	0.15	**0.79**	-0.05
Approaching	-0.07	**0.60**	-0.01
No reaction	0.08	**-0.40**	-0.13
High tail position	-0.08	0.39	0.39
Stress indicating behaviours	-0.04	-0.34	0.07
Circling	-0.04	0.03	**0.76**
Growling	-0.05	0.02	**0.75**
Looking at owner	-0.12	0.01	**0.60**
Sniffing the ground	-0.09	0.18	-0.37
High body posture	-0.02	0.30	0.35
Sniffing the visual startle	-0.11	0.05	-0.29
Proportion of explained variation %	14.6	12.9	12.7

There were no significant differences comparing type, sex or age in the three components from the principal component analysis performed on the behaviours from the 'visual startle' subtest segment three.

4.2.4 Approaching person subtest

Three components were extracted from the PCA performed on the behaviours observed in the 'approaching person' subtest (Table 9). The first component was labelled 'active fear' as the dog adopts a threatening posture in combination with vocalisation and movement. The second component was labelled 'curiosity' as it had a strong negative loading on 'latency to contact with approaching person'. The third component had negative loadings on 'contact' and 'jumping' and a moderate loading on 'support seeking' and was therefore labelled 'fear support'. Total variance explained by the three components was 41.1%.

Table 9. Rotated component matrix from the principal component analysis performed on behaviours from the 'approaching person' subtest, which the Labrador retrievers participated in. The table displays the loadings of each variable on the extracted components. Loadings of more than 0.4 are shown in bold. Sampling adequacy: Bartlett´s sphericity test $\chi^2 = 992.215$, *df = 253, P < 0.01; KMO: 0.493*

	Component		
	Active fear	Curiosity	Fear support
Circling	**0.82**	-0.06	0.14
Barking	**0.81**	0.34	-0.10
Very high body posture	**0.75**	0.15	-0.04
Hackles raised	**0.67**	**0.41**	0.02
Growling	**0.51**	-0.01	0.22
High tail position	**0.50**	0.17	0.13
Low body posture	0.38	-0.07	-0.15
Standing still	-0.35	-0.12	0.11
Sniffing	0.34	-0.02	0.08
Approaching	0.10	**0.80**	-0.28
Latency to contact with the approaching person	0.08	**-0.75**	0.40
Staying away	-0.33	**0.50**	0.31
High body posture	0.32	**0.48**	0.05
Withdrawal	0.34	**0.45**	0.16
Look away from the approaching person	-0.31	-0.36	0.05
Stress indicating behaviours	0.02	-0.35	-0.20
Look at owner	-0.15	-0.34	0.10
Fast tail movement	0.35	0.21	**-0.79**
Slow tail movement	0.08	0.20	**0.76**
Contact	-0.20	-0.16	**-0.59**

	Component		
	Active fear	Curiosity	Fear support
Jumping	-0.09	0.07	**-0.57**
Support seeking	0.10	-0.25	**0.42**
Sniffing the ground	-0.23	-0.12	0.28
Proportion of explained variation %	17.1	12.2	11.8

There were no significant differences between type, sex or age in the component 'active fear'. The component 'curiosity' showed a significant interaction between type and sex revealing that common-type males are less curious than field-type males but common-type females are more curious than field-type females (common-type male: -0.03 ± 0.19; field-type male: 0.17 ± 0.20; common-type female: 0.21 ± 0.19; field-type female: -0.45 ± 0.20; $F_{1,90} = 4.68$; $P < 0.05$, Figure 4). There was also a significant interaction between type and sex in the component 'fear support' where common-type males showed less 'fear support' than field-type males but common-type females showed more 'fear support' than field-type females (common-type male: -0.66 ± 0.19; field-type male: 0.15 ± 0.19; common-type female: 0.42 ± 0.19; field-type female: 0.11 ± 0.20; $F_{1,89} = 8.48$; $P < 0.01$, Figure 5).

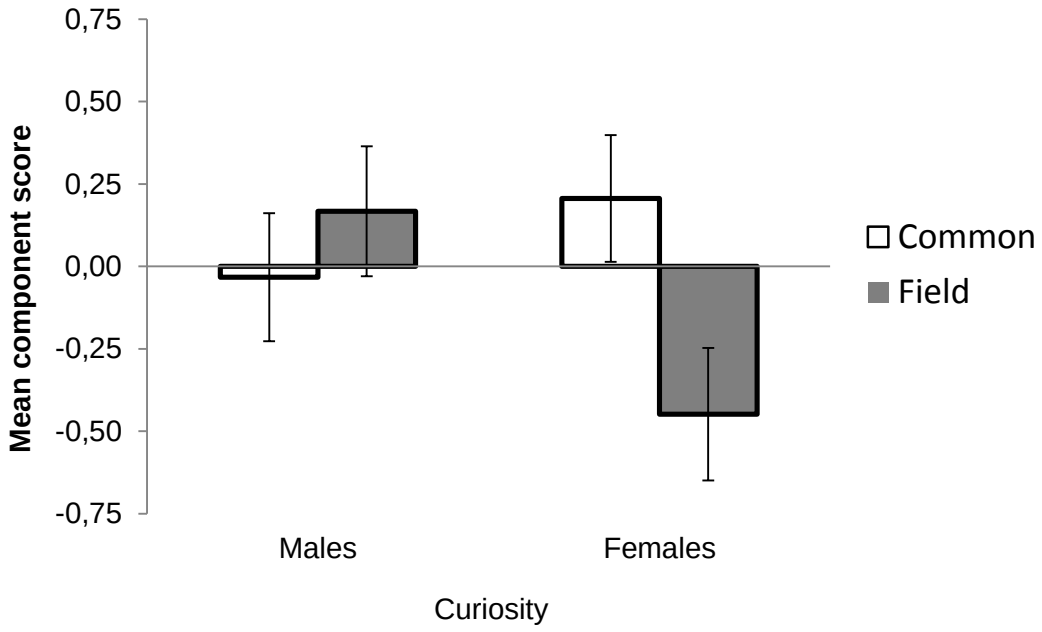

Figure 4. Mean score for the component 'curiosity' from the principal component analysis performed on behaviours from the 'approaching person' subtest. A significant interaction between type of Labrador retriever and sex can be seen. Error bars show standard error.

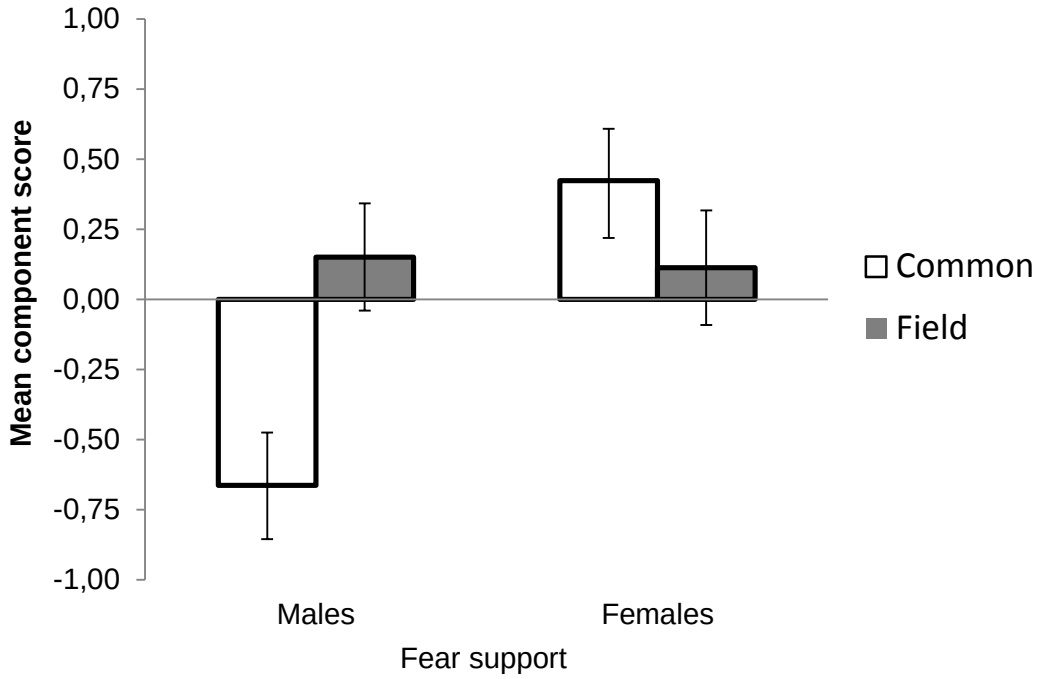

Figure 5. Mean score for the component 'fear support' from the principal component analysis performed on behaviours from the 'approaching person' subtest. A significant interaction between type of Labrador retriever and sex can be seen. Error bars show standard error.

4.3 Differences between common-type and field-type Labrador retrievers in the C-BARQ

The C-BARQ revealed that field-type Labrador retrievers scored significantly higher in 'trainability' (common type: 2.92 ± 0.07; field type: 3.18 ± 0.07; $F_{1,93} = 8.13$; $P < 0.01$), 'stranger-directed aggression' (common type: 0.15 ± 0.04; field type: 0.30 ± 0.04; $F_{1,89} = 8.82$; $P < 0.01$) and 'stranger-directed fear' (common type: 0.04 ± 0.05; field type: 0.30 ± 0.05; $F_{1,93} = 13.47$; $P < 0.01$) while the common type scored higher in 'chasing' (common type: 1.50 ± 0.12; field type: 0.91 ± 0.12; $F_{1,93} = 12.04$; $P < 0.01$, Figure 6). A significant interaction between type and sex was found in the component 'non-social fear' revealing that common-type males showed less non-social fear than field-type males, but common-type females showed more non-social fear than field-type females (common-type male: 0.20 ± 0.07; field-type male: 0.42 ± 0.07; common-type female: 0.38 ± 0.07; field-type female: 0.21 ± 0.07; $F_{1,92} = 7.67$; $P < 0.01$, Figure 7).

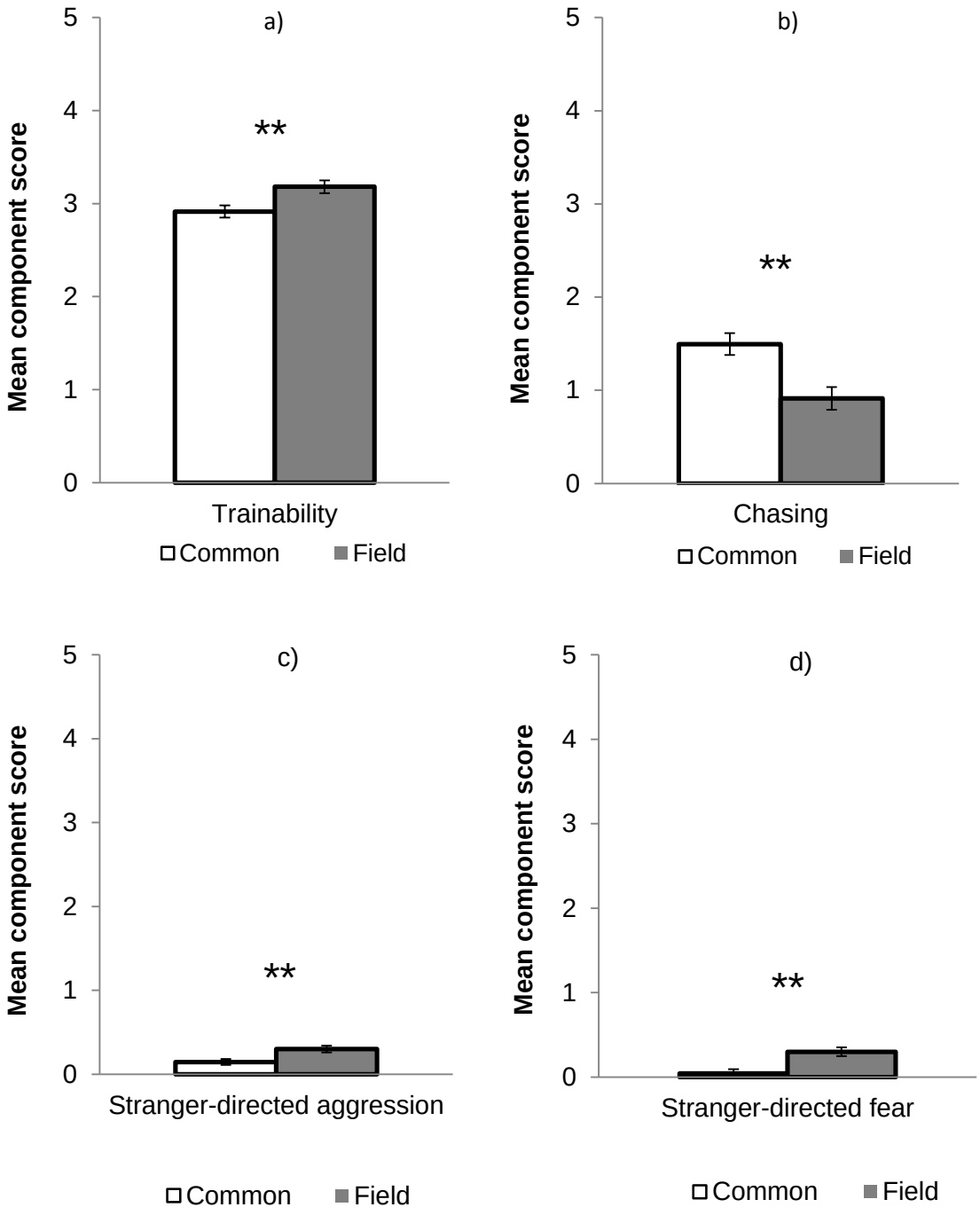

Figure 6. Mean scores for the four C-BARQ categories that differed between common-type and field-type Labrador retrievers. A) Trainability, B) Chasing, C) Stranger-directed aggression, D) Stranger-directed fear. Error bars show standard error.

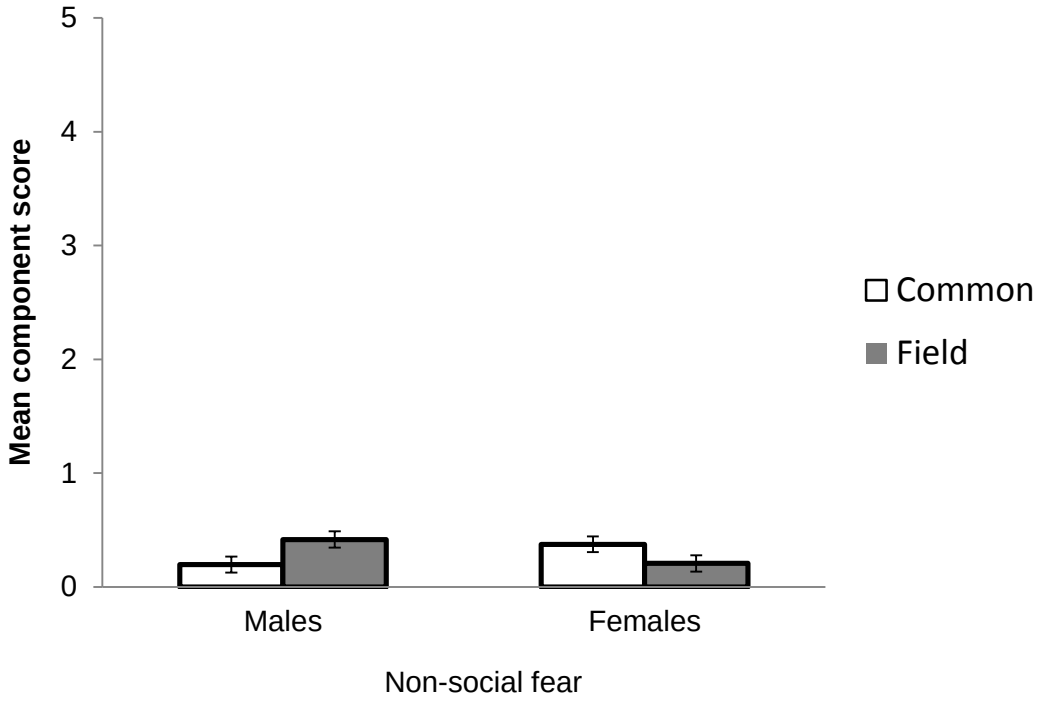

Figure 7. Mean score for the C-BARQ category 'non-social fear' which showed a significant interaction between type of Labrador retriever and sex. Error bars show standard error.

5 Discussion

The aim of the present study was to examine the effects of recent selection by investigating if there are any behavioural differences between common-type and field-type Labrador retrievers. If behavioural differences exist, these two breed lines could be good candidates for finding the genes underlying the behavioural differences, as they have a recent common gene-pool. The findings of the present study suggest that recent selection can have quite large effects on dog behaviour as the two types differed in several ways but not entirely as predicted.

The scores from the behaviour and personality test for dogs showed that common-type Labrador retrievers were more interested in meeting and greeting strangers compared to the field type. The detailed behavioural scoring of the 'strange person' subtest supports this as there was a tendency for field-type Labrador retrievers to be more disinterested in strangers than the common type. Also the C-BARQ points in the same direction as field-type Labrador retrievers were reported to show more aggression and fear towards strangers compared to the common type, which is in contrast to Duffy et al. (2008) who found no difference in stranger-directed aggression. However, there were no difference between types in the component 'social fear' from the BPD score and the C-

BARQ scores for aggression and fear towards strangers are very low. This might indicate that field type Labrador retrievers, rather than being scared of strangers, are just more indifferent towards them. The common type Labrador retrievers on the other hand, take great interest in meeting strangers. Similar results were presented by Lofgren et al. (2014) who showed that Labrador retrievers used as gundogs exhibited more human and object fear than Labrador retrievers used as show dogs. Although Lofgren et al. (2014) categorised the dogs by asking what they were used for rather than basing it on the merits of the dog's ancestors it is likely that their categorisations as show dog or gundog are similar to the present study's categorisations as common type or field type.

The results from the 'approaching person' subtest showed interactions between sex and type for both 'curiosity' and 'fear support'. The main differences were that common type females were more curious than field type females and that common type males showed less 'fear support' than field type males. The 'approaching person' subtest presents a situation which is likely perceived as more threatening by the dog than the 'strange person' subtest which can explain why there was not a clearer difference between types.

When it comes to owner-directed aggression the present study found no differences between types and neither did Lofgren et al. (2014). In contrast, Duffy et al. (2008) found that field type Labrador retrievers showed more owner-directed aggression than the common type. However, Duffy et al. (2008) studied the American Labrador retriever population while Lofgren et al. (2014) studied the U.K. population and the present study used the Swedish population. Genetic differences might exist between the American populations and the European populations, while differences between the U.K. and Swedish populations are likely smaller due to higher gene flow between the populations.

The BPD score shows that common-type Labrador retrievers exhibited less non-social fear than the field type. Additionally, the detailed behavioural scoring of the 'visual startle' subtest showed that the common-type Labrador retrievers were less nervous than the field type. However, there were no differences between types in 'active fear' or 'passive fear'. The C-BARQ category 'non-social fear' revealed a sex difference where common-type males showed less non-social fear than field-type males but common-type females showed more non-social fear than field-type females. As previously mentioned, Labrador retrievers used as gundogs have been shown to exhibit more human and object fear than show-dogs (Lofgren et al., 2014). While the results of Svartberg (2006) indicate that show-dogs in general are more fearful, he also found

that of the 31 investigated breeds, Labrador retriever scored the highest in curiosity/fearlessness.

Field-type Labrador retrievers scored higher in the C-BARQ category ‘trainability’ compared to the common type in concurrence with an earlier study (Lofgren et al., 2014). The BPD does not measure trainability per se, but field-type Labrador retrieves scored higher than the common type in the variable ‘contact at food’, which measures how much the dog looks at the owner. Dogs being more attentive to their owner could indicate a higher trainability. In contrast, a study by Svartberg (2002) using German shepherd dogs and Belgian tervuren suggested that there is a general relationship between high boldness and good performance in tasks that require varied training. However, in the present study the relationship seems to be reversed as field-type Labrador retrievers showed more non-social fear, but scored higher in trainability. This indicates that a boldness-trainability relationship may be breed specific.

Common-type Labrador retrievers scored higher in the C-BARQ component ‘chasing’ compared to the field type. Gundogs have to remain still and silent until the owner takes the shot. Thus, chase-proneness is a trait that breeders of field-type Labrador retrievers might have selected against, although it could also be part of their training.

Whether the behavioural differences between the common type and field type are due to genetic differences or differences in training is hard to say. While the dogs in the present study were selected to be as young as possible, it is a requirement of the BPD that they are at least one year of age. Thus, many of the Labrador retrievers had already received extensive training at the time of testing. About 50% of the common-type owners reported that they often train with their dog while the corresponding number for the field type was about 80%. As these two types of Labrador retriever are bred for very different roles it is likely that there are some genetic differences. Show dogs are regularly exposed to strangers and other dogs and successful show dogs need to cope well with these types of situations. This could explain why common-type Labrador retrievers are more interested in meeting strangers than the field type. Gundogs, on the other hand, need to ignore distractions and stay obedient and attentive to the owner for long periods of time which could explain why the field-type Labrador retriever scores higher in trainability than the common type. Common-type Labrador retrievers showed less non-social fear and were more prone to chasing. Svartberg (2005) found the same relationship between non-social fear and chase-proneness. It seems counter-intuitive that field-type Labrador retrievers show more non-social

fear as they have to cope with gunshots and other potentially surprising events in their capacity as gundogs. Nevertheless, Lofgren et al. (2014) also found that Labrador retrievers used as gundogs showed more human and object fear than show-dogs. These results indicate that there may be a relationship between non-social fear and trainability in the Labrador retriever which is also supported by the results of Lofgren et al. (2014). While it does seem likely that some of the differences between the two types of Labrador retriever are genetic some are probably explained by differences in training or management. A behavioural study on puppies from the two breed lines would eliminate the effects of training and could corroborate the results of the present study.

5.1 Conclusions

The present study shows that common-type and field-type Labrador retrievers differ in behaviour which could indicate genetic differences. Some behavioural differences are probably the result of intentional selection by breeders such as common-type Labrador retrievers being friendlier towards strangers and field-type Labrador retrievers scoring higher in trainability. Other differences in behaviour like show dogs exhibiting less non-social fear and more chase-proneness than the field type may be unintended side effects of selection for show or field work. As these two breed lines have only been separated a few decades, these results support the hypothesis that it is recent selection that affects a breed's behaviour rather than the origin of the breed, and are in concurrence with Svartberg (2006) and Turcsán et al. (2011).
While it is true that the origin of a breed determines what genetic material there is to work with, breeding for different purposes appears able to alter the behaviour of dogs in a few decades. These two breed lines of Labrador retriever appear to be good candidates for finding the genes underlying the behavioural differences found in the present study.

5.2 Societal & ethical considerations

Dogs are widespread in our society and take on different roles such as pet dogs, gundogs, show dogs, dogs working with security, service dogs and many more. Breeding dogs that fit these roles in the best possible way is important for the welfare of both humans and dogs. Dogs that have difficulties in coping with their roles may be stressed and develop unwanted behaviours such as chewing on furniture, defecating or urinating inside etc. These types of behaviours often affect the owner in a negative way making the dog-owner relationship less enjoyable. Research towards understanding how different behaviours are connected and interact can help breeders make decisions that produce breeds suitable for their roles in society. Also, being able to accurately describe a breed's

behaviour may help prospective dog buyers make a choice that fits both them and the dog improving the welfare of both. Another aspect of dog behavioural research is that it can help us understand the genetics behind behavioural disorders such as obsessive-compulsive disorders, which could benefit dogs and humans alike.

The ethical permit for this study was approved by the committee for ethical approval of animal experimentation in Linköping, approval no 51-13.

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8 Appendix

Table A1. Ethogram used for the detailed behavioural scoring. ^{P} shows point behaviours which means they were recorded as the number of times the behaviour was exhibited. For all other behaviours it was recorded how long time the behaviour was performed.

Behaviour	Description
Body position	
Very high	Standing erect with raised head and extended forelimbs.
High	Standing erect with raised head.
Neutral	Breed specific body posture shown under neutral condition.
Low	Forelimbs and/or hind limbs are bent so that the body posture is lower than the neutral posture.
Sitting	The dog is sitting.
Lie	The dog is lying down.
Tail position	
High	Position of the tail is higher than the neutral position of the tail.
Neutral	Breed specific tail position shown under neutral conditions.
Low	Position of the tail is lower than the neutral position of the tail.
Tail movement	
Still	No movement of the tail.
Slow wagging	The tail is moving slowly from side to side.
Fast wagging	The tail is moving with high speed from side to side.
Hackles	
Raised hackles	The dog is raising its hackles.
Reactions to stimulus	
Withdrawal	Moving away from the stimulus some steps, often sideward while facing the stimulus.
Moving/ Staying away	Moving/ Staying more than 5 m away from the stimulus.
Circling/ keeping distance	The dog is moving back and forth and/or circling the stimulus

	while holding distance to the stimulus.
Interaction with viewers	The dog is showing any kind of interaction with the viewers, e.g. approaching the viewers, seeking body contact with the viewers or hiding behind the viewers.
Looking at owner	The dog is looking at the owner.
Looking at TL	The dog is looking at the test leader.
Looking away from stimulus	The dog is looking away from the stimulus but not at the owner or TL.
Support seeking	The dog is approaching, pawing, nosing, jumping at, pushing itself against or hiding behind the owner or test leader (only owner in 'strange person' subtest).
Standing still	The dog is standing and looking at the stimulus and does not move its paws for at least two seconds.
Sniffing the ground	Air inhaled forcibly through nose with nose close to the ground.
Approaching stimulus	The dog is moving towards the stimulus or pulling and/ or stepping on the same place when restricted by the leash.
Sniffing	Air inhaled forcibly through nose while facing the stimulus at a distance not exceeding 10 cm.
Jumping	The dog is lifting up its fore paws while facing the stimulus at a distance not exceeding 10 cm.
Physical contact	The dog is touching the stimulus with its paw, nose, tongue or any other part of its body
No reaction	The dog is not performing any of the behaviours described above
Stress indicating behaviours	
Lip or nose licking [p]	Tongue extends upwards to cover lip or nose, before retracting to mouth.
Shaking off [p]	The dog is repeatedly and quickly moving its head and body from one side to the other.
Yawning [p]	Mouth opens wide for a period of a few seconds and then closes.
Vocalization	
Barking [p]	Barking sound.
Puffing [p]	The dog is rapidly exhaling a small amount of air producing a sound sounding like the mix of an exhale and a bark.
Growling	Growling sound.
Whining	Whimpering sound.

Table A2. The standardised scoring sheet used by the authorized observer to score the behaviours during the behaviour and personality test for dogs.

Link to embedded pdf-file (Swedish):

protokoll-for-bph-A4.pdf

Table A3. The method used to convert the BPD scores to the 32 more general variables the Swedish Kennel Club presents on their website.

Link to embedded pdf-file (Swedish):	 Sammanräkning_BPH _till_avelsdata.pdf

Table A4. The C-BARQ components used in this study. Items are either scored on a scale from 0 - 4 or as a frequency in which case they should be converted as follows: Never = 0, Seldom = 1, Sometimes = 2, Usually = 3 and Always = 4, except for scales 5, 6 and 7 in Section 1. For these scales only, reverse the scores to: Never = 4, Seldom = 3, sometimes = 2, usually = 1 and always = 0.

Component	Formula
Stranger-directed aggression	(items 10 + 11 + 12 + 15 + 16 + 18 + 20 + 21 + 22 + 28)/10
Owner-directed aggression	(items 9 + 13 + 14 + 17 + 19 + 25 + 30 + 31)/8
Dog-directed aggression/fear	(items 23 + 24 + 26 + 29 + 45 + 46 + 53 + 54)/8
Dog rivalry	(items 32 + 33 + 34 + 35)/4
Trainability	(items 1 + 2 + 3 + 4 + 5 + 6 + 7 + 8)/8
Chasing	(items 27 + 77 + 78 + 79)/4
Stranger-directed fear	(items 36 + 37 + 39 + 40)/4
Non-social fear	(items 38 + 41 + 42 + 44 + 47 + 48)/6
Separation-related problems	(items 55 + 56 + 57 + 58 + 59 + 60 + 61 + 62 + 63)/9
Touch sensitivity	(items 43 + 49 + 50 + 52)/4
Excitability	(items 64 + 65 + 66 + 67 + 68 + 69)/6
Attachment/attention-seeking	(items 70 + 71 + 72 + 73 + 74)/5