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Behavioural differences between and within retriever breeds

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Sammanfattning
Abstract

The retriever breeds have the same origin and have long been used as a gundog for hunting of game, mostly birds. However, recently the retriever breeds have become a popular pet and show dog. This have affected the breeding of the dogs as the same traits are not bred for a gundog and a pet or show dog. Breeds as the Labrador retriever consists of a field- and common-type. The aim of this study is to investigate any differences between and within five of the retriever breeds in behaviours as retrieving, search and game reaction. 64 dogs undergoing the field trial Description of Function- Retriever was video recorded and scores from 430 dogs that have undergone field trials was obtained. Both differences between and within breeds were found when analysing both the videos and scores. In the video analysis, the Flatcoated retriever showed the most retrieving behaviours and was the most passive. The Nova scotia duck tolling retriever was in both the video and score analyses the most active breed. The Labrador retriever scored high in game reaction. The field- and mixed-types had almost always higher scores in behaviours linked to hunting, compared to the common-type. This supports findings that recent selection in breeding have a larger effect on behaviour than the origin uses of the dogs.

Nyckelord
Keyword
Behaviour, Breed, Dog, Field test, Retreiver

Content

1 Abstract

The retriever breeds have the same origin and have long been used as a gundog for hunting of game, mostly birds. However, recently the retriever breeds have become a popular pet and show dog. This have affected the breeding of the dogs as the same traits are not bred for a gundog and a pet or show dog. Breeds as the Labrador retriever consists of a field- and common-type. The aim of this study is to investigate any differences between and within five retriever breeds in behaviours as retrieving, search and game reaction. The breeds were Golden retriever, Labrador retriever, Flatcoated retriever, Curly Coated retriever and Nova Scotia Duck Tolling Retriever. 64 dogs undergoing the field trial Description of Function- Retriever was video recorded and scores from 430 dogs that have undergone field trials was obtained. Both differences between and within breeds were found when analysing both the videos and scores. In the video analysis, the Flatcoated retriever showed the most retrieving behaviours and was the most passive. The nova scotia duck tolling retriever was in both the video and score analyses the most active breed. The Labrador retriever scored high in game reaction. The field- and mix-types had almost always higher scores in behaviours linked to hunting, compared to the common-type. This supports findings that recent selection in breeding have a larger effect on behaviour than the origin uses of the dogs.

2 Introduction

The dog (*Canis familiaris*) was the first animal to be domesticated by humans in South East Asia, about 11 000-16 000 years ago (Freedman et al., 2014). Evidence of the first dog types is dated to 3000-400 years BP (cited by Svartberg, 2006 from Hartcourt “The dog in prehistoric and early historic Britain.” 1974). Dog types such as hunting, guard, sheep and lap dogs were defined during Roman times (cited by Svartberg, 2006 from Clutton-Brock “Origin of the dog: domestication and early history” 1995). The proliferation of dog breeds occurred in the middle ages in Europe (cited by Merkram and Wynne, 2014 from Clutton-Brock “Origin of the dog: domestication and early history” 1995). Today we have a large number of dog breeds, over 1000 breeds (Morris, D., 2008), that vary in their morphology, fur color, size and built to name a few. One of the most used examples is the difference in the size between the Chihuahua with the weight of about 1 kg and Mastiff that weigh about 100 kg (Wayne and vonHoldt, 2012).

It is not only morphology that differentiates dog breeds, they also differ in behavior, e.g. heading and retrieving (Wayne and vonHoldt, 2012; Coppinger and Coppinger, 1996; Mehrkam and Wynne, 2014; Spady and Ostrander 2008) and personality (Svartberg, 2006). There is, for example, a variation of behaviours between breed groups, which is a cluster of breeds that are similar in behaviour and function, and sometimes also in appearance. Genetic subdivision based on single-locus SNP data have been shown to correspond to the phenotypic and functional breed groups (vonHoldt et al., 2010). However not only breed groups are classified by their behaviour, individual breeds are also often classified by their behaviour (Coppinger and Coppinger, 1996). There is a strong genetic component for the variation in dog behaviours (Coppinger and Coppinger, 1996). Moderate heritability for behaviours that are important for retrievers such as the use of nose, search, retrieve from water and cooperation with humans have been showed (Schmutz and Schmutz, 1998).

The evolution of dogs that have caused the huge variety of breeds is thought to consist of two principles. One is the principle of the fixation of discrete mutations in individual lineages that are crossed to several breed groups. This means that few but significant genes are mutated in these individual lineages and when crossed with other breed groups causes a high phenotypic diversity. The other is the selective breeding within separate phenotypic or functional groups, which improves the specific attributes of the breed groups (Wayne and vonHoldt, 2012). The origin of some behaviours can either be shared by the dog ancestor or subjected by human selection. For example, the behaviour of running after a dead or wounded game to retrieve it, retrieving, is a behaviour the wolf also performs, and is part of the wolf predatory behaviour. However, the softer grip on the game that makes sure that the game do not get damaged by the dogs' teeth, a trait called "soft mouth", was possibly a product of artificial selection (Schmutz and Schmutz, 1998)

The history of the retrievers begins in the second half of the 1800 as the hunt for pheasant became popular in England. A dog with many different hunting traits was needed. The dog needed to be quiet and calm before the shooting as to not scare the game. It needed to be fast in order to get the wounded game, have endurance to perform well all day and also have a 'soft mouth' so it would not damage the game it brought back to its master. There are two stories of how the retriever was created. One is that they bred different dog breeds that already existed on the English estates. The other is that all retrievers originates from the S:t Johns Dog, a dog used by the Canadian fishermen that came with the European immigrants.

The S:t Johns Dog already had several of the traits desired, but with the use of different breeds, like pointers and setters, the modern retriever was developed. The retrievers were first a heterogenic group of dogs and breeders evolved them to different types with different ideals which lead to the breeds we have today (SKK, 2006). In a study using genetic analysis, the retrievers were found to belong in the same cluster (Pollinger et al., 2010). The retriever breeds are the Labrador Retriever, Golden Retriever, Chesapeake Bay Retriever, Nova Scotia Duck Tolling Retriever, Flatcoated Retriever and Curly Coated Retriever.

Although retrievers have been bred for retrieving, there might be some difference in retrieving behaviour between them, e.g due to different selections in the different breeds. There was only one study found investigating the retrieving behaviour, and that was performed on the Flat coated retriever, with it performing scoring high in retrieving (Lindberg et al 2004). The retriever breeds are not solely used for hunting today, but more commonly used for show or companionship. Studies on other behaviours have shown difference in curiosity/fearlessness between retriever breeds (Svartberg, 2006). Due to the new use of the dogs for show or companionship, selection on other traits, like appearance and handling acceptance, have become more common. Selection differ even within the breeds. This divides some breeds into different types, depending on the recent selection. The Labrador retriever is a good example and the breed club has even acknowledged a field- and common-type of the breed (SKK, 2005). Differences between work and show lines in Labrador retriever and Border collie have been found for responsiveness with work lines in both breeds scoring higher than the show line (Fadel et al, 2016).

Field trials are often used to assess dogs' behaviour and is helpful in breeding in order to preserve and enhance favourable behaviours, like herding and hunting traits (Arvelius et al., 2013; Arvelius and Klemetsdal, 2013). In Sweden, the Swedish Spaniel and Retriever Club (SSRC), the largest association for hunting breeds in Swedish Kennel Club (SKC), was concerned that the hunting and working tests might not be enough to preserve and enhance the breed specific behaviors of the retrievers. Therefore, the Description of Function-Retriever (DF-R) was established, an assessment focusing on the retrieving hunting breeds. It evaluates behaviours that are important of the retrievers, like willingness to retrieve, engagement in search and game reaction (SSRK, 2014).

The aim of this study is to investigate if there are any differences in behaviour, especially in the retrieving behaviour, between and within the retriever breeds. This was achieved by analysing video recorded subtests

and scores from the Description of Function-Retriever. The hypothesis is that there should be a difference in behaviour both between and within the retriever breeds as both have been reported in other behaviours, such as curiosity/fearlessness and responsiveness, and breeding selection differ between and within the breeds. The prediction is that the Flat coated and Labrador retriever will be the breeds performing the most retrieving behaviours and both be good in search, based on Lindberg et al (2004) findings on the Flat coated retriever and the specific breeding strategy (SBS) for the Labrador retriever (SKK, 2005). The SBS for the Labrador also indicates that the breed should perform well in game reaction, at least better than the Flat coated retriever, as its SBS states that game-spontaneity needs improvement (SKK, 2012b). For all breeds that consist of a common- and field-type, the field type is predicted to show more retrieving behaviour and outperform the common-type, as field-type dogs have been breed for field work.

3 Material & methods

3.1 Animals

In this study, behavioural data from the Description of Function-Retriever (DF-R), was obtained from the SKC for 430 dogs. The breeds of the dogs consisted of Golden retriever (GO), Labrador retriever (LA), Flatcoated retriever (FL), Curly Coated retriever (CC) and Nova Scotia Duck Tolling Retriever (NS). The age of the dogs ranged from one to ten years (Table 1). 64 of these dogs were video recorded when being assessed (Table 2). The video recordings were obtained at different DF-R test occasions.

The dogs were classified as either field, mix or common type. In order to be considered a field type, the ancestors three generations back had to be field bred. A dog was classified as a mixed-type if half or more, but not all, ancestors three generations back was field bred and as common if fewer or none was field bred. The classification was done by analysing the dogs' pedigrees for field trial and show titles of the three generations and further back. Pedigrees from SKC online registry Hunddata (2016) and the database K9data.com (2016) were used.

Table 1. Distribution of breed, type, sex and age for the 430 dogs that have been tested in the DF-R.

Breed (N)	Type (N)	Males	Females	Mean age ± SE (years)	Total age ± SE (years)
CC (22)	Common (22)	8	14	1.73 ± 0.19	1.73 ± 0.19
FL (71)	Common (58)	27	31	1.87 ± 0.25	1.98 ± 0.14
	Mix (13)	8	5	2.51 ± 0.52	
LA (55)	Common (29)	13	16	1.53 ± 0.12	1.50 ± 0.09
	Field (26)	13	13	1.46 ± 0.14	
GO (227)	Common (147)	69	78	1.98 ± 0.10	1.93 ± 0.08
	Mix (44)	22	22	1.61 ± 0.12	
	Field (36)	19	17	2.09 ± 0.27	
NS (55)	Common (55)	25	30	1.45 ± 0.07	1.45 ± 0.07
All (430)		204	226		1.81 ± 0.05

Table 2. Distribution of breed, type, sex and age for the 64 dogs that have been video recorded during the Description of Function-Retriever.

Breed (N)	Type (N)	Males	Females	Mean age ± se (years)	Total age ± se (years)
CC (8)	Common (8)	3	5	2.55 ± 1.05	2.55 ± 1.05
FL (26)	Common (14)	6	9	1.93 ± 0.30	2.02 ± 0.18
	Mix (11)	7	4	2.13 ± 0.01	
LA (1)	Common (1)	1	0	1.93 ± 0.00	1.93 ± 0.00
GO(23)	Common (22)	9	13	1.38 ± 0.15	1.36 ± 0.14
	Mix (1)	1	0	1.01 ± 0.00	
NS (6)	Common (6)	3	3	1.71 ± 0.14	1.71 ± 0.14
ALL (64)		30	34		1.81 ± 0.05

3.2 Description of function-retriever

The Description of function-retriever (DF-R) is an official field test for retriever breeds consisting of 11 subtests. See Table 3 for short description of the subtests and appendix Table A1 for full description.

The dogs' behaviour was scored by a certified judge on an intensity scale ranging from 1 to 5. Low numbers indicating either low intensity, low commitment to task or no reaction and high numbers indicating either high intensity, high commitment to task or strong reaction.

A dummy is often used to train retrieving and is a substitute for a dead bird. It has a cylindrical form and is fabric covered and stuffed. The dummy used in the regular retrieving was about 450-500 g. In the second retrieving with the heavy dummy it weighed 4,5 kg. The long dummy in the retrieving long dummy was 120 cm long and consisted of five pillows sewed together that resembled regular dummies. More information about the dummies used can be found in the full description of the subtest in Table A1.

Table 3. The 11 subtests of the Description of function-retriever with short description.

Subtest	Description
Retrieving regular dummy	A dummy is placed approximately 20 meters from the dog. The dog is released by the owner with a neutral command to retrieve it. This was done two times.
Retrieving heavy dummy	A heavy dummy is placed approximately 20 meters from the dog. The dog is released by the owner with a neutral command to retrieve it.
Retrieving long dummy	A long dummy is placed approximately 20 meters from the dog. The dog is released by the owner with a neutral command to retrieve it.
Passivity	The owner stands still with the dog on leash for 2 minutes, not interacting with the dog.
Moving object	The dog is released by the owner with a neutral commando towards a flappy dummy. Before the dog reach it, it is pulled backwards from the dog.
Passivity with teasing	The owner stands still with the dog on the leash for 2 minutes, not interacting with the dog. During this passivity a functionary teases the dog with a dummy as he or she prepare for the search test.
Search	The dog is released by the owner towards the search area where a functionary has been making a trail with a dummy.

Problem Solving	The dog is made to retrieve a dummy near a spruce covered plastic net box. Next the dummy is placed inside the box and the dog is released again.
Game	A dead game bird is placed approximately 20 meters from the dog. The dog is released by the owner with a neutral command to retrieve it.
Passivity	The owner stand still with the dog on the leash for 2 minutes, not interacting with the dog.
Gunshot	The owner stands still with the dog and two gunshots are fired.

3.3 Data collection

64 of the dogs undergoing the DF-R were video recorded using a Canon Legria HF G25 camera during the field test for further behavioural analysis. The videos were analysed using Noldus Observer XT. As retrieving was the main focus, all three retrieving tests were analysed. Also the three passivity occasions were analysed, as it can give an insight to how the dogs behave when nothing is expected of them.

For the three retriever tests, behaviour both regarding retrieving and non-retrieving was observed. Ethogram is provided in Table 4. Continuous recording was used and the time each behaviour was performed was recorded. The observed time of the retrieving test differed, due to that some dogs performed the retrieving faster than others and some more slowly. Therefore, the recorded time for each behaviour was divided with the total observed time to get a percentage.

Table 4. Ethogram for the three retrieving tests of the DF-R. The amount of time each behaviour was performed was recorded.

Behaviour	Description
Running towards dummy	The dog is moving towards the dummy.
Gripping dummy	The dog grips the dummy with its mouth.
Returning with dummy	The dog is moving towards the owner with the dummy in its mouth.

Dropping dummy	The dog drops the dummy to the ground.
Interacting with dummy	The dog interacts with the dummy with its mouth, paws or other body parts without gripping it.
Returning without dummy	The dog is moving towards the owner without the dummy.
Exploring surroundings	The dog moves around and or interact with the surrounding environment.
Moving with dummy	The dog is moving with the dummy in its mouth, but not in the owners direction.
Gazing towards owner or audience	The dog is directing its head towards the owner or audience.

For the passivity occasions, behaviours such as body and tail posture and movement, gazing, vocalisation and interaction with owner and environment were analysed, for more details see table 5.

Table 5. Ethogram used for analysing dogs during three passivity occasions in the Description of Function- Retriever. The amount of time each behaviour was performed was recorded for most of the behaviours if nothing else is stated.

Behaviour	Description
Dog posture and position	
Very high	The dog is standing upright with raised head and stretched forelimbs.
High	The dog is standing upright with raised head.
Neutral	Breed specific body posture held under neutral state.
Low	The dog is bending its forelimbs and/or hind limbs with a body posture lower than the neutral breed specific posture
Sitting	The dog is sitting with its behind touching the ground.
Lie	The dog is lying down on the ground.
Activity	
Standing	All dog´s paws is touching the ground in a standing position.
Sitting	The dog is sitting with its behind touching the ground.
Lying down	The dog is lying down on the ground.
Walking	The dog is moving forward by lifting its paws.
Movement	The dog is not moving forward but lifting its paws.
Tail position	

High	The dog's tail is in a higher position than the neutral position.
Neutral	The dog's tail is in neutral breed specific position.
Low	The dog's tail is in a lower position than the neutral position.

Tail movement

Still	The dog's tail is not moving.
Slow wagging	The dog's tail is moving sideways at slow pace.
Fast wagging	The dog's tail is moving sideways at high speed.

Stress (measured in bouts)

Lip or nose licking	Tongue extends outside the mouth to cover dog's lip or nose.
Shaking off	The dog is repeatedly and quickly moving its head and body from one side to the other.
Yawning	The dog opens its mouth wide for a couple of seconds and then closes.
Scratching	The dog scratched itself.

Dogs position

Owner	The dog is standing, sitting or moving in proximity to owner, less than 1 meter away.
Leash end	The dog is standing, sitting or moving at the end on the leash. With leash taunt.
Between	The dog is standing, sitting or moving 1 meter from the owner to near the end of the leash.

Gazing

Owner	The dog is gazing towards the owners face.
Audience	The dog is gazing towards the audience.
Environment	The dog is neither looking at owner, audience or search area.
Search area	The dog is gazing towards the search area.

Pulling

Pulling on leash	Dog pulls on leash.

Interactions

Owner	The dog is touching owner with nose, paw or other parts of its body.
Nose	The dog touching parts of environment with nose.
Sniffing	The dog inhales forcibly through nose less than 10 cm from ground or parts of the environment.
Chewing	The dog takes part of the environment into its mouth and moves its jaws.
Digging	The dog drags paws repentantly on the ground.

Vocalization (measured in bouts)

Barking	The dog is emitting a barking sound.
Puffing	The dog is emitting a mix of an exhale and a bark by exhaling a small amount of air fast.
Growling	The dog is emitting a growling sound.
Whining	The dog is emitting a whimpering sound.

3.4 Statistical analysis

3.4.1 Component reduction

A Principal Component Analysis (PCA) was used to analyse both the official scores from the 430 dogs and the more detailed behavioural analysis of the 64 video recorded dogs. One PCA was performed on the official scores. For the detailed behavioural analysis, four PCAs were performed, one for each retrieving task and one for the passivity tasks.

To determine the number of components to extract for the PCA, a scree test was used to act as a guide (Osborne and Costello, 2009). The component matrix was rotated using Varimax rotation and variables was calculated as regression scores. The minimum interpretable loadings were 0.3 and are makes as bold in all component matrixes.

3.4.2 Effects of breed, type, sex and age

To investigate the effects of breed, type, sex and age, General Lineal Models (GLM) were used. Since no effects were found for age it was excluded from the model. Also, two GLMs were performed on each component, one with breed and sex, the other with type and sex for each breed consisting of more than one breed type. As there was only one Labrador Retriever in the group of the video recorded dogs, it was excluded from the GLM analyses. A Tukey post-hoc test was used to see which groups differed.

All statistical analysis was done with IBM SPSS Statistics 23 with the significant level set at 0.05.

4 Results

4.1 Differences between and within retriever breed for retrieving a regular dummy

The PCA for the first video-analysed retrieving test, with a regular dummy, yielded one component (Table 6). The strongest loaded variables were retrieving behaviours and some non-retrieving behaviour. The

retrieving behaviours loaded negative and the non-retrieving loaded positive. This component was named retrieving. The component explained 37.2 % of the variance.

Table 6. Component matrix from the principal component analysis of the behaviours of the "retrieving of a regular dummy" test, which the 64 video analysed dogs underwent. Sampling adequacy: Bartlett´s sphericity test $\chi 2$ = 197,805, df = 36, P < 0.00; KMO: 0.595.

Behaviours	Component
	Retrieving
Returning with dummy	**-0.878**
Running towards dummy	**-0.834**
Exploring surroundings	**0.726**
Gripping dummy	**-0.624**
Dropping dummy state	**0.613**
Looking towards owner or audience	**0.514**
Returning without dummy	**0.404**
Interacting with dummy	**0.344**
Moving with dummy	0.222
Percentage of variance explained %	37.2

The GLM for breed and sex showed that there was an significant effect of breed on 'retrieving' ($F_{3,60}$= 0.145; P< 0.002, Figure 1), with the FL showing higher scores than the GO ($F_{3,59}$=5.621; P< 0.001). There was also a difference within the FL with the mixed-type performing more retrieving behaviours than the common-type ($F_{1,25}$= 5,221; P=0.031, Figure 4).

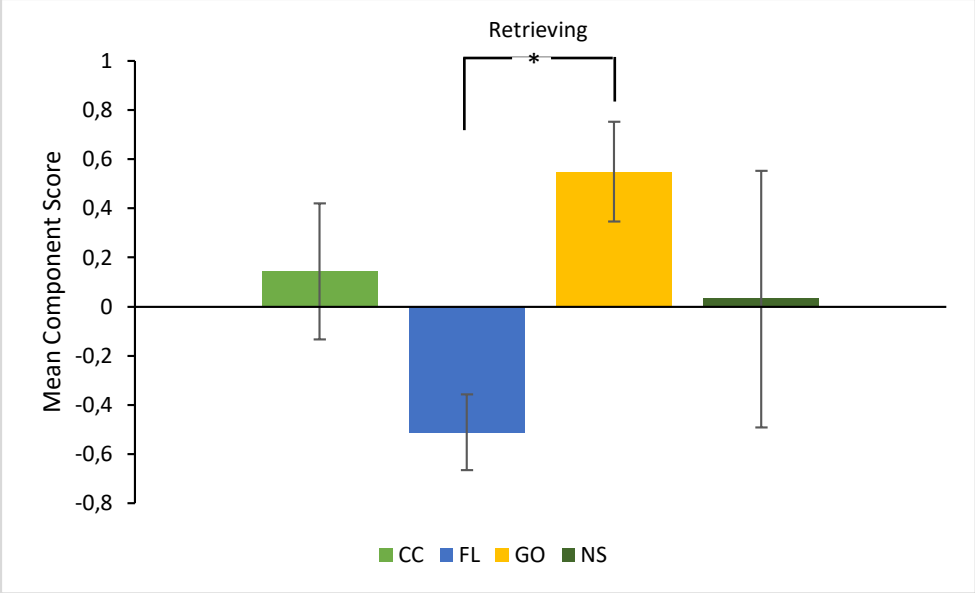


*Figure 1. Mean component scores from the principal component analysis of the behaviours of the "retrieving of a regular dummy" subtest, comparing the FL, CC, FL, GO and NS. * indicates a significant difference P>0.05. Error bars show standard error.*

4.2 Retrieving of a heavy dummy

The PCA for the second video-analysed retrieving test, retrieving of a heavy dummy, yielded three components. The first component loaded high on retrieving behaviours, and was named 'retrieving'. The second component was labelled 'difficulties gripping dummy', as it loaded high on 'looking towards human' and 'interacting with dummy' and moderate, but negative, on 'dropping dummy' and 'gripping dummy'. The last was labelled 'disinterest in dummy' as it loaded high and positive on 'exploring surroundings' and 'returning without dummy' and negative on 'moving with dummy'. The three components total variance explained was 54.06 %.

Table 7. Component matrix from the principal component analysis of the behaviours of the "retrieving of a heavy dummy" test, which the 64 video analysed dogs underwent Sampling adequacy: Bartlett´s sphericity test $\chi 2 = 100.116$, df = 36, P < 0.00; KMO: 0.544

Behaviours	Component		
	Retrieving	Difficulties gripping dummy	Disinterest in dummy
Running towards dummy	**0.888**	0.093	0.140
Returning with dummy	**0.854**	-0.148	-0.011
Exploring surroundings	**-0.553**	0.027	**0.466**
Dropping dummy	**0.488**	**-0.345**	-0.112
Looking towards owner or audience	-0.140	**0.745**	-0.227
Interacting with dummy	0.112	**0.726**	0.147
Gripping dummy	0.091	**-0.399**	-0.020
Moving with dummy	-0.194	-0.093	**-0.784**
Returning without dummy	-0.149	-0.065	**0.602**
Percentage of variance explained %	25.01	14.79	14.26

When investigating for effect and interactions with GLM, there was no effect of breed or sex for 'retrieving' and 'difficulties gripping dummy', but for 'disinterest in dummy' there was an effect of sex and interaction of breed and sex. Males showed more disinterest than females (Male: -0.30 ± 0.13; Female: 0.371 ± 0.21; $F_{1, 62}$=5.054; P=0.029) and the male CCs were more disinterested than the breed's females (CC-male: -1.48 ± 0.23 ; CC-female: 0.98 ± 0.47 ; $F_{6,57}$= 2,374; P=0.041). There was an effect of type within the FL ($F_{1, 25}$=5.583; P=0.027, Figure 4)

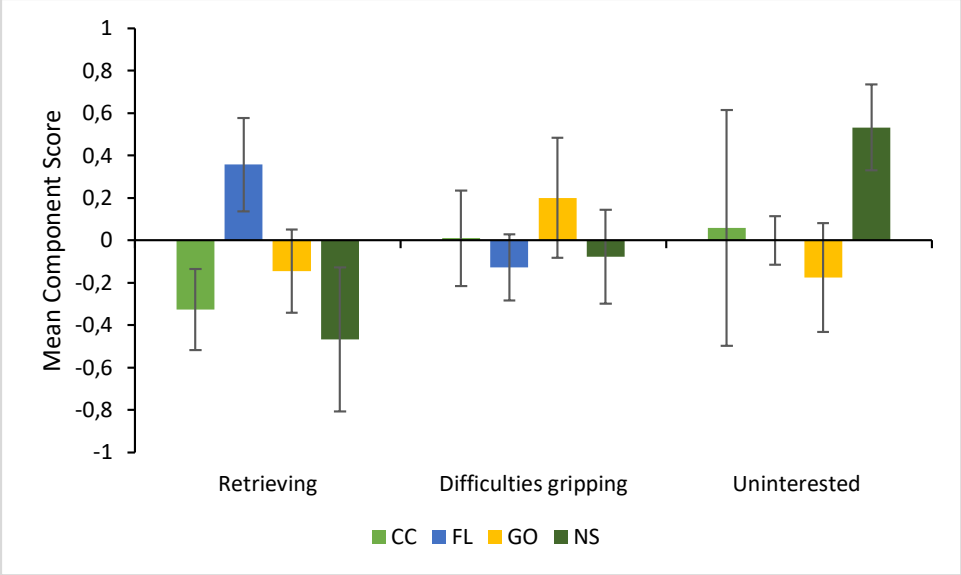


Figure 2. Mean component scores from the principal component analysis of the behaviours of the "retrieving of a heavy dummy" subtest, comparing the CC, FL, GO and NS. Error bars show standard error.

4.3 Retrieving of a long dummy

The PCA for the third video-analysed retrieving test had two components. The first component was labelled 'retrieving', as it loaded high on 'returning with dummy', 'running with dummy' and 'gripping dummy'. The second loaded high on 'moving with dummy', 'dropping dummy' and high negative loading on 'returning without dummy', and therefore was labelled 'disinterest in returning'. The two components total variance explained was 54.06 %.

Table 8. Component matrix from the principal component analysis of the behaviours of the "retrieving of a regular dummy" test, which the 64 video analysed dogs underwent FL. Sampling adequacy: Bartlett´s sphericity test $\chi 2 = 103.739$, df = 36, P < 0.00; KMO: 0.665

Behaviours	Component	
	Retrieving	Disinterest in returning
Returning with dummy	**0.869**	0.052
Running towards dummy	**0.807**	-0.208
Gripping dummy	**0.758**	-0.071

Interacting with dummy	-0.229	-0.177
Moving with dummy	-0.065	**0.716**
Returning without dummy	**-0.433**	**-0.512**
Dropping dummy	-0.058	**0.501**
Exploring surroundings	**-0.442**	**-0.476**
Looking towards owner or audience	**-0.366**	**0.432**
Percentage of variance explained %	28.45	16.86

There was no effect of either breed or sex for the two components when using the GLM. When comparing the different types of FL, no significant effect or interactions were found.

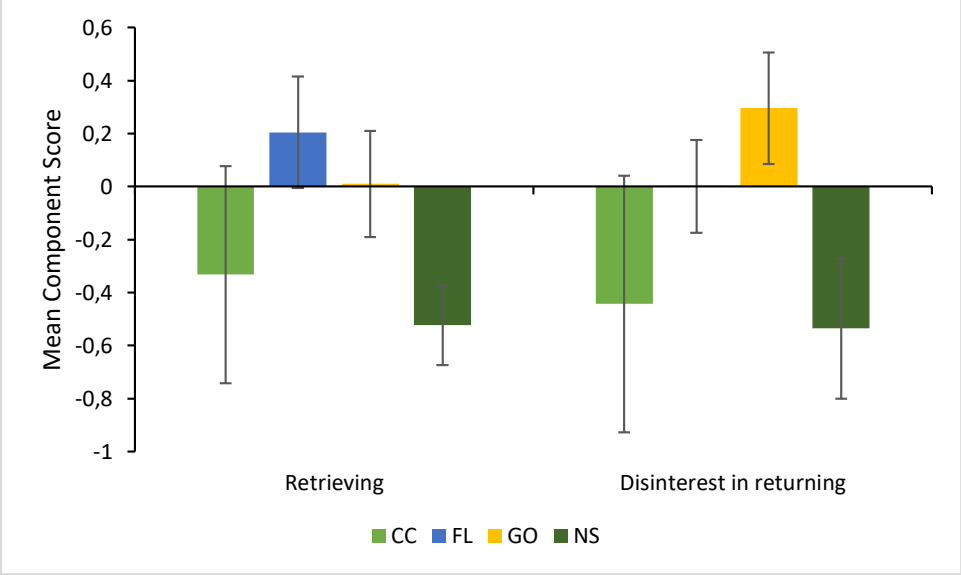


Figure 3. Mean component scores from the principal component analysis of the behaviours of the "retrieving of a long dummy" subtest, comparing the FL, CC, FL, GO and NS. Error bars show standard error.

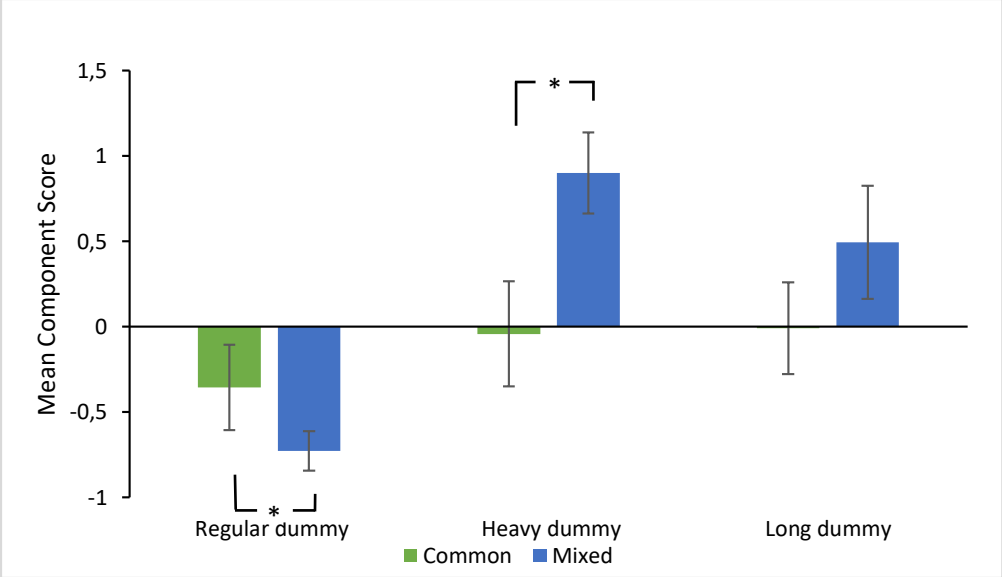


*Figure 4. Mean component scores from the principal component analysis of the retrieving behaviours of the "retrieving of a regular dummy", "retrieving of a heavy dummy" and "retrieving of a long dummy" subtest, comparing the common- and mixed-type of FL. * indicates significant difference P<0.05. Error bars show standard error.*

4.4 Differences between and within retriever breeds during the passivity task

The PCA for the video analysis of the passivity task yielded three components. The first component was labelled 'passivity' as it loaded high on behaviours such as 'standing' and 'neutral posture'. The second was labelled 'activity' as it loaded high on 'sniffing' and 'movement' and negative on 'sitting'. The third loaded high on behaviours related to stress such as 'scratching' and 'shaking off' and on being in the search zone and the behaviour 'pulling', therefore labelling the component 'excitement/stress'. The three components total variance explained was 32.39 %

Table 8. Component matrix from the principal component analysis of the behaviours of the "Passivity" test, which the 64 video analysed dogs underwent DF-R. Sampling adequacy: Bartlett´s sphericity test $\chi 2$ = 919.276, df = 496, P < 0.00; KMO: 0.465

Behaviours	Component		
	Passivity	Activity	Excitement/stress

Low tail	**0.881**	0.030	-0.204
Standing	**0.822**	0.022	**-0.317**
Neutral posture	**0.761**	0.040	**-0.313**
Still tail	**0.637**	-0.110	-0.159
Gazing Audience	**0.607**	0.026	0.019
Gazing Search area	**0.399**	-0.138	0.173
Gazing Owner	**-0.345**	0.013	0.114
Physical interaction owner	-0.220	0.009	-0.161
Licking Total number	-0.188	-0.067	-0.120
Chewing	-0.127	-0.086	-0.089
Nose	0.076	0.040	0.025
Sniffing	0.147	**0.671**	-0.047
Sitting	-0.127	**-0.593**	0.088
Movement	0.245	**0.552**	0.146
High tail	-0.327	**0.490**	0.027
Low posture	0.167	**0.487**	0.219
Whining Total number	-0.280	**0.486**	0.**375**
Barking Total number	-0.257	**0.479**	-0.030
Fast wagging tail	-0.**345**	**0.408**	-0.**301**
High posture	-0.098	**0.389**	-0.002
Lying down	-0.169	**-0.387**	0.099
Gazing Environment	0.000	0.220	-0.034
Between	0.158	-0.176	-0.149
Search Zone	-0.063	0.235	**0.643**
Slow wagging tail	-0.185	-0.104	**0.640**
Owner zone	**0.439**	**-0.355**	**-0.605**
Pulling	-0.062	-0.219	**0.578**
Shaking off Total number	-0.002	0.229	**0.576**
Scratching Total number	-0.027	-0.170	**0.437**
Walking	-**0.376**	**0.398**	**0.411**
Leash end	0.052	-0.047	**0.364**
Neutral tail	-0.033	-0.004	-0.243
Percentage of variance explained %	16.23	9.19	6.97

For the 'passivity' component there was an effect of breed ($F_{3,60}$= 2.848; P= 0.045, Figure 5). Post hoc Tukey test showed that the FL was more passive than the other breeds ($F_{3,59}$=2.848; P=0.045). There was also an effect of type were the mixed-type FL was more passive than the common-type (Common-type: 0.81 ± 0.28; Mixed-type: -0.16 ± 0.29; $F_{1,25}$= 5,221; P=0.031).

An effect of breed was also seen in the 'active' component ($F_{3,60}$= 3.892; P= 0.013, Figure 5), with the NS being more active than the GO and FL ($F_{3, 59}$=3.892; P=0.013).

There was an effect of breed for the 'excitement/stress' ($F_{3,60}$= 2.848; P= 0.045, Figure 5). The GO and the NS showed more 'excitement/stress' than the other breeds ($F_{3,59}$= 7.900; P< 0.001). The GLM performed on the FL scores showed that there was an interaction of type and sex, where the common-type female and mixed-type male showed more 'excitement/stress' than the common-type male and mixed-typed female (Common male: -0.72 ± 0.32; Common female: 0.01 ± 0.20; Mix male: -0.49 ± 0.20; Mix female: -1.32 ± 0.38; $F_{3,23}$=3.50 P=0.033).

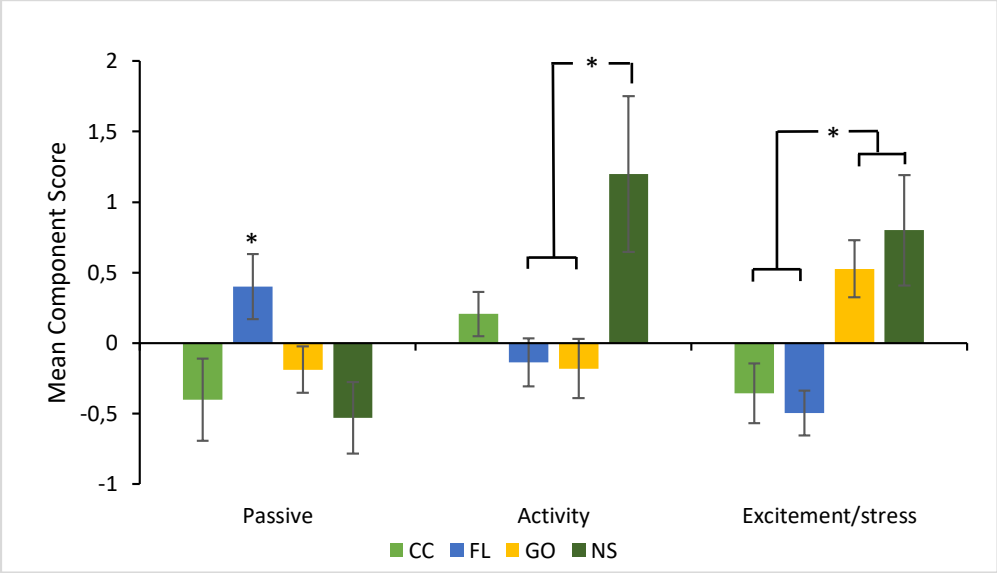


*Figure 5. Mean component scores from the principal component analysis of the behaviours showed during the passivity tasks in the Description of function- retriever, comparing the CC, FL, GO and NS. * indicates a significant difference P<0.05. Error bars show standard error.*

4.5 Between and within breed difference in the Description of Function-Retriever test of the retriever breeds

The principal component analysis of the scores from the Description of function- Retriever yielded four components. The first component loaded high on several variables that has to do with the grip and hold of the dummy in the retrieving subtests, and was labelled 'grip and hold of

dummy'. The second was labelled 'commitment and endurance' as it loaded high on 'commitment' and 'endurance/time' for the search and problem solving subtests. The third was labelled 'game reaction' as the component loaded high on all the variables for the game subtest. The fourth component loaded high on 'activity' during passivity and 'interest', and got the label 'activity'. The four components explain a total variance of 46.98 %.

Table 9. Component matrix from the principal component analysis of the scores from the 430 dogs that have been tested in the Description of function - Retriever. Intensity scale for all behaviours can be found in Table A1. Sampling adequacy: Bartlett´s sphericity test $\chi 2 = 919.276$, df = 496, P < 0.00; KMO: 0.465

Behaviours	Component			
	Grip and hold of dummy	Commitment and endurance	Game reaction	Activity
3a Grip/handlersupport	**0.747**	-0.005	0.184	-0.018
3c Hold	**0.709**	0.013	0.126	-0.137
3e Play with object	**0.699**	-0.040	-0.053	0.129
2a Grip/handlersupport	**0.693**	0.143	0.173	0.019
3b Gripping/regripping	**0.670**	0.149	0.011	0.150
5c Grip/handlersupport	**0.644**	0.269	0.161	0.036
2c Hold	**0.607**	0.258	0.207	-0.130
2e Play with object	**0.599**	0.138	0.092	0.270
5d Play with object	**0.554**	0.165	-0.058	0.183
5b Curiousity	**0.518**	0.224	-0.036	0.039
2d Way in	**0.516**	0.313	0.329	-0.274
5a Following	**0.499**	0.248	-0.007	-0.029
3d Way in	**0.491**	0.136	0.302	**-0.398**
2b Gripping/regripping	**0.469**	0.160	0.021	0.049
1b Way out	**0.363**	**0.329**	0.001	0.061
8e Contact handler	**0.301**	0.294	-0.165	-0.169
7d Commitment	0.159	**0.789**	0.068	0.037
7a Endurance/time	0.124	**0.777**	0.056	0.061
7b Ground coverage	0.105	**0.763**	0.051	0.028
8c Endurance/time	0.215	**0.747**	0.070	0.077
8b Commitment	0.208	**0.721**	0.067	0.082
7c Speed	0.295	**0.718**	-0.002	0.084
8d Physical attempts	0.207	**0.646**	0.197	0.072

1e Carrying	**0.359**	**0.545**	0.130	-0.369
1c Gripping	**0.520**	**0.530**	0.117	-0.113
1f Way in	**0.320**	**0.509**	0.167	**-0.426**
1d Hold	**0.472**	**0.481**	0.089	-0.127
8a Respect	-0.043	**-0.463**	-0.124	-0.056
7e Contact handler	0.061	-0.293	-0.144	-0.202
9a Grip	0.169	0.229	**0.868**	-0.046
9c Hold	0.169	0.215	**0.866**	-0.087
9b Gripping/regripping	0.146	00.197	**0.801**	-0.001
11b Fear	-0.008	0.001	-0.273	0.157
6b Sound	0.178	0.061	-0.139	**0.673**
1a Interest placing	0.203	0.150	0.041	**0.626**
4b+10b Sound passivity	0.002	0.014	0.044	**0.585**
4a+10a Activity passivity	-0.021	-0.063	-0.002	**0.546**
6a Interest	0.199	0.280	-0.198	**0.541**
11a Interest	-0.059	0.046	-0.207	**0.391**
Percentage of variance explained %	26.62	8.40	7.42	4.54

The GLM analysis yielded several effects and interactions for the four components. There was an effect of breed for 'grip and hold of dummy' ($F_{4,414}$= 10.278; P>0.001, Figure 6) with the CC scoring lower than the other breeds ($F_{4,413}$=5.207; P>0.001). There was also an interaction of breed and sex with the GO males scoring higher than the females (GO male: 0.18 ± 0.086; GO female: -0.36 ± 0.10; $F_{5,413}$= 3.700; P=0.003). A tendency was found between the types of GO ($F_{2,215}$=2,661; P=0.072, Figure 7b) there the field-type scored higher than the common-type ($F_{2,214}$=2.862; P=0.053).

For 'commitment and endurance' there was an effect of breed, sex and type. The effect of breed ($F_{4,414}$= 16.005; P>0.001, Figure 6) showed that the FL had higher scores than the GO and NS, also the LA scored higher than the GO ($F_{4,414}$= 15.822; P>0.001). When it came to sex differences, males had higher scores than females (Male: 0.09 ± 0.066; Female: -0.08 ± 0.071; $F_{1,417}$= 3.930; P=0.048). The within-breed comparison showed that the mixed-type FL had higher scores than the common type ($F_{1,70}$= 5.393; P=0.023, Figure 7) and the mix- and field-type GO had higher scores than the common type ($F_{2,215}$= 23.304; P<0.001, Figure 7)($F_{2,214}$= 23.304; P>0.001). There was a tendency within the LA with the field-

type having a higher score than the common-type ($F_{1,53}$= 3.286; P=0.076, Figure 7)

There was an effect of breed for 'game reaction'. The LA had higher scores than all breeds except the FL ($F_{4,414}$= 4.305; P=0.002, Figure 6). Effects was also found within the GO ($F_{2,215}$= 9.731; P<0.001) with the mixed- and field-type GO scoring higher than the common-type GO ($F_{2,214}$= 9.252; P<0.001).

An effect of breed was found for the last component 'activity'($F_{4,414}$= 10.463; P>0.001, Figure 6) with the NS being more active than the other breeds and the LA scoring lower than the GO ($F_{2,214}$= 10.137; P<0.001). Also a type difference in the FL was found ($F_{1,70}$= 9.077; P=0.004) were the common-type FL had higher score than the mixed-type. Also in the GO there was a type effect ($F_{2,215}$= 9.731; P<0.001) with the mixed- and field-type scoring lower than the common-type ($F_{2,214}$= 6.920; P<0.001). In the LA, there was a tendency with the field-type scoring higher than the common-type ($F_{1,53}$= 3.055; P=0.087, Figure 7).

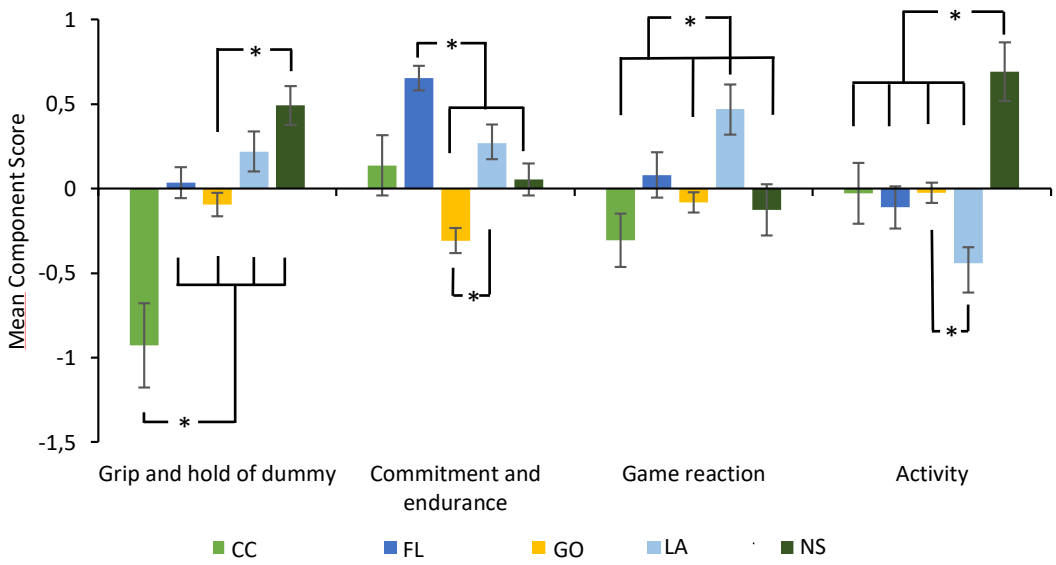
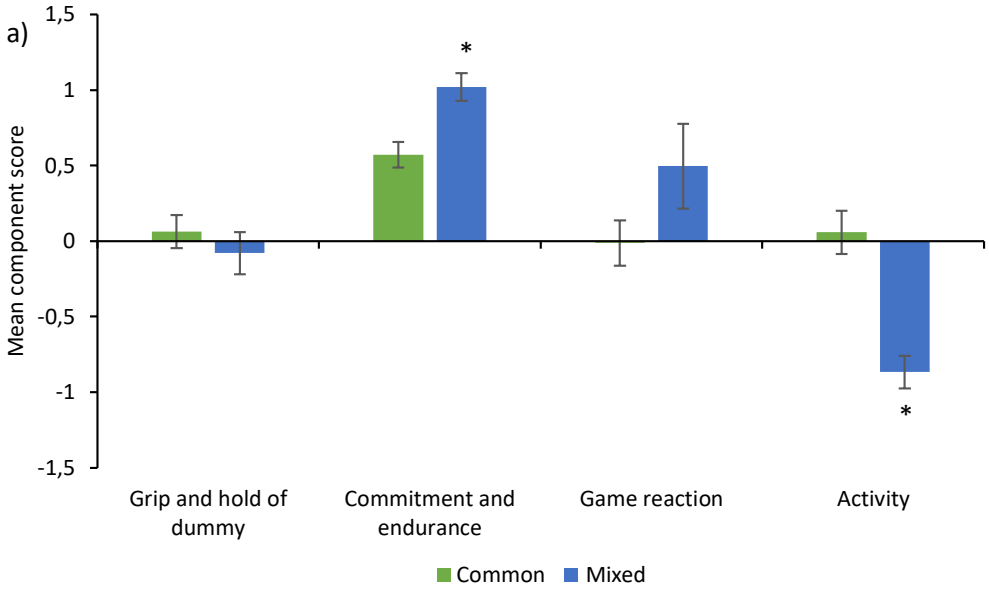
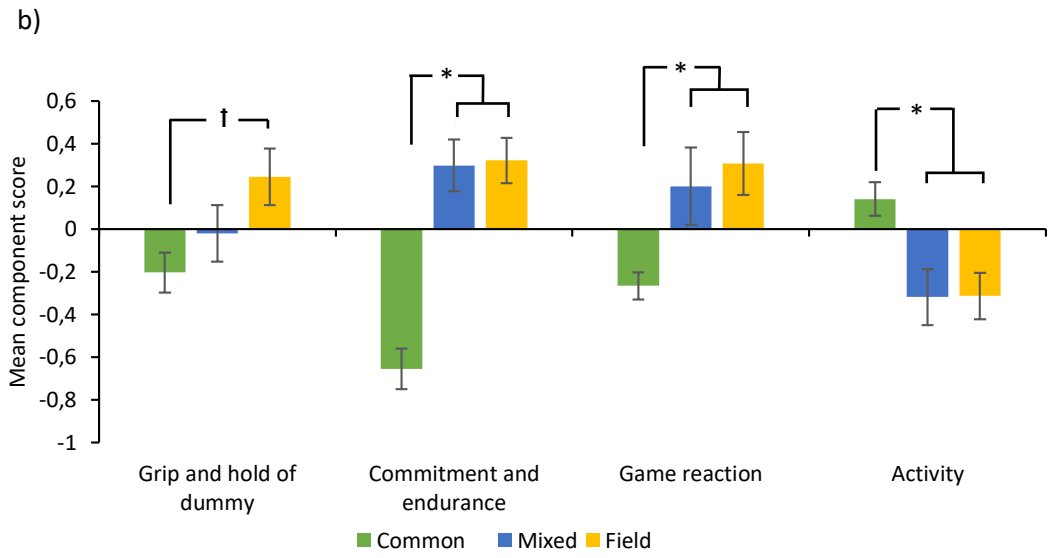


*Figure 6. Mean component scores from the principal component analysis of the scored behaviours from the Description of function - retriever. Comparison of the CC, FL, GO, LA and NS. * indicates a significant difference. Error bars show standard error.*


a)
Mean component score
1,5
1
0,5
0
-0,5
-1
-1,5
*
*
Grip and hold of dummy
Commitment and endurance
Game reaction
Activity
Common
Mixed


b)
Mean component score
0,6
0,4
0,2
0
-0,2
-0,4
-0,6
-0,8
-1
†
*
*
*
Grip and hold of dummy
Commitment and endurance
Game reaction
Activity
Common
Mixed
Field

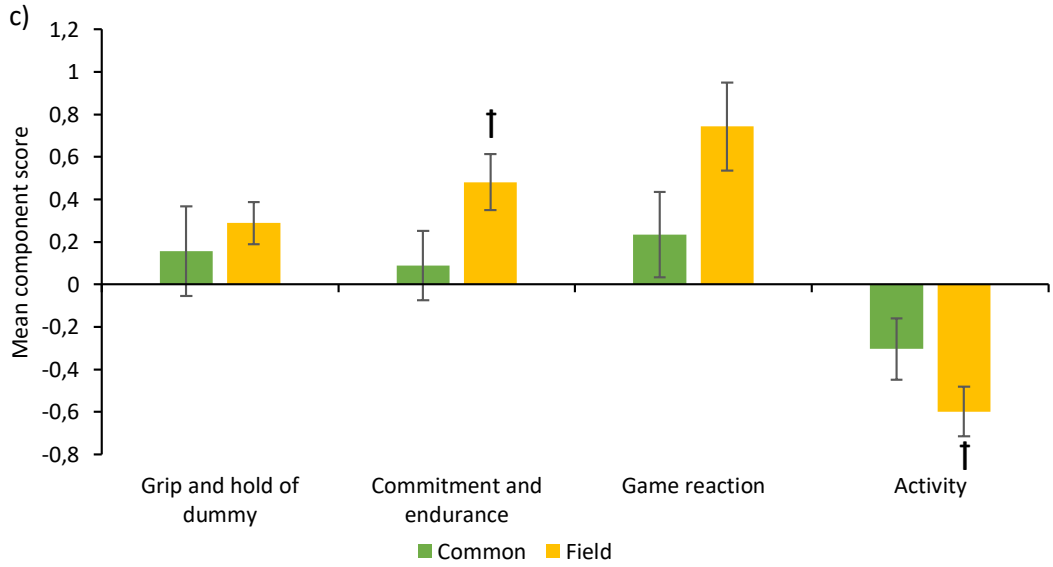

c)
Mean component score
1,2
1
0,8
0,6
0,4
0,2
0
-0,2
-0,4
-0,6
-0,8
†
†
Grip and hold of dummy
Commitment and endurance
Game reaction
Activity
Common
Field

*Figure 7. Mean component scores from the principal component analysis of the scored behaviours from the Description of function - retriever. Comparison of the two types of FL (a), three types of GO (b) and two types of LA (c). * indicates a significant difference P<0.05 and † indicates P<0.1. Error bars show standard error.*

5 Discussion

In this study I investigated the behavioural differences between and within the retriever breeds by analysing video recordings and test scores from the DF-R. Several differences were found in both aspects.

FL showed more retrieving behaviours during video analysing than GO during the retrieving of a regular dummy. FL was predicted to perform retrieving behaviours as Lindberg et al (2004) found that FL scored high in retrieving in a test for FL by the Swedish FLcoated Retriever Club that scored with an intensity scale like in the DF-R. In the same subtest the dogs 'interest in search' were scored and the mean score for the FL in the test was high, indicating interest in search. That also correlates with results in this study there FL scored high in commitment and endurance during search and problem-solving, higher than GO and NS. The test also consisted of a subtest there the dogs were 'waiting passively in a group', there low scores meant that the dog was more passive, and the mean score for the FL were low and therefore indicated that FL were passive. In this study the dog did not wait in a group but alone with their owner, but FL showed more passive behaviours than GO, CC and NS. All these three results indicated that the FL in this study have the traits that makes a good gundog; willingness to retrieve, the endurance to not tire and being calm when its master is so.

Together with FL, LA also scored high in commitment and endurance during search and problem-solving, at least higher than GO. This was also predicted as the breed specific breeding strategy for LA (SKK 2005) stated that the breed is useful for search for ungulates. This could also explain why LA scored high in game reaction, more so than GO, CC and NS, and means that LA in this study were interested in game.

GO showed less retrieving behaviours than FL. Even if the statistical analysis did not yield any effect of age, the two breeds mean age did differ. The video recorded GO and FL had a mean age of 1.36 and 2.02 years respectively. FL therefore had a higher age and could therefore have a higher experience than GO. Lindberg et al (2004) found that experience affected retrieving behaviours in FL there FL with more

experience had stronger reaction than FL with less experience. More experience could mean that the dogs have been more trained and therefore might be higher likely to perform the retrieving than a dog with less training. The retrieving subtests were performed with a neutral command, if possible with the owner just taking a step towards the dummy, in order to try to eliminate the effect of training. However, a dog trained a lot in retrieving could still find a neutral command as a retrieving command and if they trained with similar dummies it could also be more of training than instinct.

GO and NS both showed more excitement and stress behaviours during the three passivity subtests than FL and CC. Svartberg (2006) found that during the standardised test "dog mentality assessment" GO and NS ranked in the bottom of 31 breeds in the traits curiosity/fearlessness thereof the FL and LA ranked in the top. An insecure or fearful dog is more likely to become stressed in novel situations, that the passivity test could be as the owner is told to ignore the dog and even if the audience is standing at least 10 meters from the dog they could been seen as intimidating. In addition, the breed specific breeding strategy for the GO have a goal for less stressed golden, indicating that stress in the breed have been observed (SKK, 2012a).

In both the video analysis and test score analysis, NS showed more active behaviours and scored higher in activity than the other breeds, except for CC in video analysis. As mentioned before the retriever breeds original use is that of a gundog and one of the traits desired of them is that of calmness before the shooting of the bird. NS however is used to lure bird into shooting range by e.g. playing (SKK, 2014) and this could be the reason for the NS high activity compared to the other breeds.

LA, FL and GO all consisted of more than one type and in all three there was an effect of type. Across all three breeds the mixed- and/or field-type scored higher in commitment and endurance during search and problem-solving and as this is strongly linked to field work, it was predicted. As field breed dogs are breed on willingness to retrieve and commitment in search. Schmutz and Schmutz (1998) found moderate heritability for use of nose and search, this trait is affected by the different breeding selection between the types.

All three breeds also differed in activity, even if LA the difference was a trend. It was consistent in all breeds that the mixed- and/or field-type scored lower in activity compared to the common-type. This could be interpreted that the mixed and field-types were more passive as they had lower intensity regarding activity. In the field, gundogs are to be still and

quiet by their master's side until the shooting, then they expected to retrieve the killed game. Therefore, being passive in a setting as in the 'passivity' task could be something that is bred for in field bred dogs. However, in the video analysis the mixed-type FL showed less passive behaviours compared to the common-type. As mention before, Lindberg et al (2004) found that FL were passive when 'Waiting passively in a group', but this differed with dogs' experience and this could explain why the common-type FL was more passive than the mixed-type. But it is not certain as the dogs' experience in this study is not known. It could also be because of training from the owners. Fadel et al, (2016) found that working LA was more 'responsive' than show LA and speculated that it could be because people that get a LA for work purposes could be more expected to train them to be passive. Similar results were found by Lofgren et al (2014) but with 'trainability', with the working LA having a higher score than pet and show LA.

Field-type GO had higher scores in grip and hold of dummy during the retrieving of the heavy and long dummy, compared to the common-type, though the difference was a trend. This is then linked to retrieving as it includes handling the dummy, there a low score means that the dog e.g. does not grip it, need support from owner or/and have a to lose grip of it and drops it. The mixed-type of FL showed significantly more retrieving behaviours during the retrieving of the regular and heavy dummy, compared to the common-type. The two types did not differ in age that could exclude experience by age. However as discussed before with passivity, the difference could be explained that owners that require a more field breed dog might train it more than an owner getting a common-type dog. Still, the breeding selection can be the reason for the mixed-type FL more performed retrieving behaviours and the field-type GO scoring higher in grip and hold of dummy than the common-type. Another result that could support this is that CC scored the lowest in grip and hold of dummy of all breed and it consisted of only common-type dogs. However, NS scored significantly higher than GO in this, and NS also consisted of only common-type dogs.

CC, NS and GO were the breeds that had lower game reaction scores (compared to LA), and NS and GO had lower commitment and endurance during search and problem-solving than FL (GO lower than LA also) could be explained by the fact that CC and NS in this study consists as mentioned only of common-type dogs. Why GO joins them could be because the ratio of the types shifts towards common-type as they represented over half of the GO group.

The differences between the types and also between them could be due to different breeding selection. Svartberg (2006) found that breed-typical behaviour has been affected by recent selection rather than the original breeds function and that only a few generations seems to affect the behaviours. With this he stressed the need to consider the behaviour of dogs in breeding. One way to achieve this could be the DF-R.

In the bred specific breeding strategy for CC (SKK, 2006), it states that there has been a decrease in the number of dogs that start in the field trial and have a goal that more dogs will start. Also GO and LA bred specific breeding strategy (SKK 2012a, SKK 2005) have the same goal. Field trials are performed during a real hunting situation or stimulated hunting situations in order to investigate how the dog behaves in different hunting circumstances and is therefore also a way to keep track of the retrievers hunting abilities. If a retriever dog owner is not interested in hunting, they might not have their dog taking the field trial. The DF-R is an easier alternative that still inspect hunting related behaviours in retrievers, and is therefore a good tool to get information about the important retriever abilities for breeding.

Behavioural studies of recorded tests and analysing the test scores set by judges with an intensity scale is rather different but both have pros and cons. With the video-analysis I could measure time and bouts of a large set of behaviours but was limited by the distance sometimes to see smaller attributes in the dog's behaviours. The judges are limited as they cannot look at as many behaviours, as they score the dogs as they go. They have however been trained to see things as how the dog is holding the dummy that I could not determine from my videos. The scoring tries to not be subjective with the use of the intensity scale, but as there are different judges scoring it could be.

5.1 Societal & ethical considerations

As the results in this study supports that recent selection have an effect on behaviours of the retrievers, it points to the importance of selecting which traits to breed on. Also that it is important to examine the behaviours frequently as it can change in the span of a few generations. Field-trials as the Description of Function-Retriever therefore serve as a good tool to keep track of the retriever breeds.

Breeding where appearance is a higher priority than behaviour and not investigate the behaviour of the dogs enough could lead to problematic behaviour of the dogs, both for the dogs themselves and humans, like stress or aggressiveness. Making test like the Behaviour and Personality test for dogs and DF-R important for breeding.

No ethical considerations were needed for this study as the dogs were video recorded.

5.2 Conclusions

In conclusion, differences were found between the retriever breeds in several behaviours but most related to hunting. These hunting related behavioural differences were also found within the breeds and shows that breeding selection seem to have an effect on these behaviours. This supports that recent selection have a bigger impact on behaviour than the origin of the breeds as Svartberg (2006) found is the case with some breed-typical behaviours. This points to the importance of investigating the behaviours in breeds as the retrievers and the DF-R could serve as a good tool for this. The differences also make the retrievers a good group of breeds to investigate the underlying genetics behind not only retrieving behaviour but other field work behaviours linked to search and game interest. As the different breeding that exist today have created a difference even within the retriever breeds.

6 Acknowledgement

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8 Appendix

Table A1. Subtest description for Description of Function- Retriever.

Link to pdf	http://ssrk.se/images/stories/FBR/Anvisningar_DF-R_20160206.pdf

Table A2. Scoring sheet with intensity scale for Description of Function-Retriever for scoring of dogs behaviour in the substest.

Link to pdf	http://www.ssrk.se/images/stories/Ingangssidan/Nyckel_DF-R_2016.pdf