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Supplemental information

Breed, age, and social environment are associated with personality traits in dogs

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This PDF file includes:

Supplementary tables (S1 to S12), related to STAR Methods.
Supplementary figures (S1 to S6), related to Table 1 and Figure 1.
Data S1. R Code, related to STAR Methods

Other Supplementary Materials for this manuscript include the following:

Supplementary Data S2. Supplementary results consisting of pairwise contrasts between categorical variable levels, related to Table 1.

Table S1. Breeds and breed groups, related to STAR Methods.

Australian Shepherd	**Belgian shepherd dogs**	**Bernese Mountain Dogs**	**Bichon type dogs**
Australian Shepherd	Groenendael	Appenzell Cattle Dog	Bichon Frise
Miniature American Shepherd	Laekenois	Bernese Mountain Dog	Bolognese
	Malinois	Entlebucher Mountain Dog	Coton de Tulear
	Tervueren	Greater Swiss Mountain Dog	Havanese
			Löwchen
			Maltese
			Russian Tsvetnaya Bolonka
Brachycephalic dogs	**Bull type terriers**	**Dachshunds**	**English herders**
Boston Terrier	Bull Terrier	Miniature Longhaired	Australian Cattle Dog
Bulldog	Miniature Bull Terrier	Miniature Shorthaired	Australian Kelpie
French Bulldog	Staffordshire Bull Terrier	Miniature Wirehaired	Australian Koolie
Olde English Bulldogge		Rabbit Longhaired	Bearded Collie
Pug		Rabbit Shorthaired	Lancashire Heeler
		Rabbit Wirehaired	Old English Sheepdog
		Standard Longhaired	Welsh Sheepdog
		Standard Shorthaired	
		Standard Wirehaired	
European sighthounds	**Fighting dogs**	**German spitz related breeds**	**Hunting terriers**
Borzoi	American Bulldog	Eurasier	Bedlington Terrier
Deerhound	American Bully	Giant Spitz	Border Terrier
Greyhound	American Pit Bull Terrier	Medium size Spitz	Cairn Terrier
Hungarian Greyhound	American Staffordshire Terrier	Miniature Spitz	Cesky Terrier
Irish Wolfhound	Cane Corso	Japanese Spitz	Dandie Dinmont Terrier
Italian Sighthound	Dogo Argentino	Keeshond	Fox Terrier Smooth
Polish Greyhound	Presa Canario	Pomeranian	Fox Terrier Wire
Silken Windhound		Volpino Italiano	German Hunting Terrier
Spanish Greyhound			Glen of Imaal Terrier
			Lakeland Terrier
			Norfolk Terrier
			Norwich Terrier
			Scottish Terrier
			Skye Terrier
			Welsh Terrier
			West Highland White Terrier
Asian primitive breeds	**Livestock guardian dogs**	**Mastiff type dogs**	**Middle European herders**
Akita	Boerboel	Boxer	Beauceron
American Akita	Catalan Sheepdog	Broholmer	Bouvier des Ardennes
Chow Chow	Caucasian Shepherd Dog	Bullmastiff	Bouvier des Flandres
Hokkaido	Central Asian Shepherd Dog	Dogue de Bordeaux	Briard
Kai	Estrela Mountain Dog	Great Dane	Croatian Sheepdog
Kishu	Maremma Sheepdog	Landseer	Mudi
Korea Jindo Dog	Pyrenean Mastiff	Leonberger	Picardy Sheepdog
Shar Pei	Pyrenean Mountain Dog	Mastiff	Polish Lowland Sheepdog
Shiba	Sarplaninac	Newfoundland	Portuguese Sheepdog
Shikoku	Slovakian Chuvach	Saint Bernard Longhaired	Puli
Tosa	South Russian Ovcharka	Saint Bernard Shorthaired	Pumi
	Spanish Mastiff		Pyrenean Sheepdog Longhaired
	Tatra Shepherd Dog		Pyrenean Sheepdog Smooth Faced
	Tibetan Mastiff		
	Tornjak		
Middle European utility dogs	**Northern companion spitzes**	**Northern hunting spitzes**	**Other breed**
Bohemian Shepherd	Icelandic Sheepdog	East Siberian Laika	Australian Cobberdog
Ceskoslovensky Vlcak	Norwegian Buhund	Finnish Spitz	Australian Labradoodle
Dalmatian	Swedish Lapphund	Karelian Bear Dog	Golden Labrador Retriever
Dobermann	Swedish Vallhund	Norrbottenspitz	Indian Pariah Dog

Dutch Shepherd Dog Longhaired		Norwegian Elkhound	Peruvian Hairless Dog Large
Dutch Shepherd Dog Rough haired		Russian European Laika	Peruvian Hairless Dog Medium sized
Dutch Shepherd Dog Shorthaired		Swedish Elkhound	Peruvian Hairless Dog Miniature
East European Shepherd		West Siberian Laika	Seskar seal dog
Hovawart			Unknown breed
Rottweiler			Wolfdog
Saarloos Wolfdog			Xoloitzcuintle Intermediate
Schipperke			Xoloitzcuintle Standard
Other companion dogs	**Parson type terriers**	**Pinschers/Schnauzers**	**Pointers**
Affenpinscher	Brazilian Terrier	Black Russian Terrier	Blue Picardy Spaniel
Alaskan Klee Kai	Parson Russell Terrier	German Pinscher	Braque du Bourbonnais
Australian Silky Terrier	Working Jack Russell Terrier	Giant Schnauzer	Brittany
Cavalier King Charles Spaniel		Schnauzer	Deutsch Drahthaar
Griffon Belge			Deutsch Kurzhaar
Griffon Bruxellois			Deutsch Langhaar
King Charles Spaniel			English Pointer
Kromfohrlander			English Setter
Lhasa Apso			Gordon Setter
Papillon			Irish Red and White Setter
Pekingese			Irish Red Setter
Petit Brabancon			Large Munsterlander
Phalene			Old Danish Pointer
Shih Tzu			Pont Audemer Spaniel
Tibetan Spaniel			Portuguese Pointer
Tibetan Terrier			Small Munsterlander
			Spinone Italiano
			Stabyhoun
			Vizsla
			Weimaraner Longhaired
			Weimaraner Shorthaired
			Wirehaired Pointing Griffon
			Wirehaired Vizsla
Poodles	**Primitive sighthounds**	**Retrievers/Flushing Dogs**	**Scenthounds**
Poodle Medium	Afghan Hound	American Cocker Spaniel	American Foxhound
Poodle Miniature	Andalusian Hound	American Water Spaniel	Barak Hound
Poodle Standard	Basenji	Barbet	Basset Fauve de Bretagne
Poodle Toy	Cirneco dell’Etna	Chesapeake Bay Retriever	Basset Hound
	Ibizan Hound Smooth	Clumber Spaniel	Bavarian Mountain Hound
	Ibizan Hound Wire	Curly Coated Retriever	Beagle
	Pharaoh Hound	English Cocker Spaniel	Bracco Italiano
	Podenco Orito	English Springer Spaniel	Braque d’Auvergne
	Portuguese Podengo Medium	Field Spaniel	Drever
	Portuguese Podengo Medium Smooth	Flat Coated Retriever	Estonian Hound
	Portuguese Podengo Medium Wire	Irish Water Spaniel	Finnish Hound
	Portuguese Podengo Miniature Smooth	Kooikerhondje	Grand Basset Griffon Vendeen
	Portuguese Podengo Miniature Wire	Portuguese Water Dog	Griffon Fauve de Bretagne
	Ratonero Bodeguero Andaluz	Welsh Springer Spaniel	Istrian Coarse-haired Hound
	Rhodesian Ridgeback		Italian Rough Haired Segugio
	Saluki		Italian Short Haired Segugio
	Sloughi		Petit Basset Griffon Vendeen
	Thai Ridgeback		Plott
			Posavatz Hound
			Russian Hound
			Swiss Hound
Sled dogs	**Teacup dogs**	**Welsh Corgis**	**Yard terriers**
Alaskan Husky	Biewer Terrier	Welsh Corgi Cardigan	Airedale Terrier

Alaskan Malamute	Chihuahua	Welsh Corgi Pembroke	American Hairless Terrier
Chukotka Sled Dog	Chihuahua Longhaired		Australian Terrier
Greenland Dog	Chihuahua Smooth haired		Danish Swedish Farmdog
Samoyed	Russian Toy Dog Longhaired		English Toy Terrier
Siberian Husky	Russian Toy Dog Smooth haired		Irish Soft Coated Wheaten Terrier
Yakutian Laika	Yorkshire Terrier		
			Irish Terrier
			Kerry Blue Terrier
			Manchester Terrier
			Prague Ratter
			Rat Terrier
			Tenterfield Terrier
			Toy Fox Terrier
Individual Breeds	Jack Russell Terrier	Mixed breed	Smooth Collie
Border Collie	Labrador Retriever	Nova Scotia Duck Tolling Retriever	Spanish Water Dog
Chinese Crested Dog	Lagotto Romagnolo		Whippet
Finnish Lapphund	Lapponian Herder	Rough Collie	White Swiss Shepherd Dog
German Shepherd Dog	Miniature Pinscher	Schapendoes	
Golden Retriever	Miniature Schnauzer	Shetland Sheepdog	

Table S2. Variables derived from the dog personality and unwanted behaviour questionnaire, related to STAR Methods.

Variable	Description	Levels
Insecurity factor score	Continuous variable. Factor score of personality trait Insecurity, with higher score indicating higher insecurity.	Continuous
Training focus factor score	Continuous variable. Factor score of personality trait Training focus, with higher score indicating higher training focus.	Continuous
Energy factor score	Continuous variable. Factor score of personality trait Energy, with higher score indicating higher activity/playfulness.	Continuous
Aggressiveness/ dominance factor score	Continuous variable. Factor score of personality trait Aggressiveness/dominance, with higher score indicating higher aggressiveness/dominance.	Continuous
Human sociability factor score	Continuous variable. Factor score of personality trait Human sociability, with higher score indicating higher human sociability.	Continuous
Dog sociability factor score	Continuous variable. Factor score of personality trait Dog sociability, with higher score indicating higher dog sociability.	Continuous
Perseverance factor score	Continuous variable. Factor score of personality trait Perseverance, with higher score indicating higher perseverance.	Continuous
Sex	Categorical variable. Sex of the dog.	Female Male
Age when personality section was answered	Continuous variable. Calculated by substracting the dog's date of birth from the answering date and converting this to years.	Continuous, in years
Breed/breed group	Categorical variable. Breed was indicated by the owner and some breeds were grouped into breed groups based on genetic relatedness, use of the breed and known behavioural similarities.	See Supplementary Table S1
Sterilisation status	Categorical variable. Owners indicated whether their dog was neutered.	Intact Neutered
Main reason for ownership/use of the dog	Categorical variable. Owners selected the main reason/use of their dog, indicating their perception of the dog.	Family member Dog hobbies/work Pet
Obtained from	Categorical variable. Owners indicated where they obtained their dog from.	The dog was born at the owner's home From a breeder Rescue/previous owner: Dog is a rescue/stray or came from a previous owner or obtained from elsewhere
Level of socialisation	Categorical variable. We first performed PCA with polychoric correlation matrix, no rotation and Thurstone scoring method. Then we	Q1 = lowest Q2 Q3

	divided this continuous variable into quartiles.	Q4 = highest Obtained after the socialisation period
Living place	Categorical variable. Owners indicated their living environment.	Rural: In a rural area Urban: In a city center or in a city/town, but outside the center
Other dogs in the household when acquired	Categorical variable. Owners indicated whether they had other dogs (living in the same household) when they acquired this particular dog.	No Yes
Other dogs in the household currently	Categorical variable. Owners indicated whether they currently have other dogs living in the same household with this dog.	No Yes
Daily exercise	Categorical variable. Owners were asked to consider how many hours/minutes they walk their dog during a typical day.	Under 1 hour 1-2 hours 2-3 hours Over 3 hours
Frequency of hobbies	Categorical variable. Owners indicated the frequency of hobbies both at home and outside of their home (e.g. with an instructor). The frequency of hobbies variable is a combination of these questions. Most common dog hobbies were dog shows, agility, and obedience training.	Never/no hobby: Never or does not have hobbies Infrequent: Infrequent frequency of hobbies either at home or outside, or both Active only outside: High frequency of hobbies, but only outside of home Active only at home: High frequency of hobbies, but only outside of home Active: Active both at home and outside
Average time spent alone	Categorical variable. Owners stated how much time their dog spends alone (without people present) during a typical working day.	Under 1 hour 1-3 hours 3-6 hours 6-8 hours Over 8 hours
Life experience of dogs	Categorical variable. Owners chose whether they had family dogs in childhood/adolescence.	Dogs in the family from/in childhood Dogs in the family since adolescent years First dog in adulthood, no dogs in the family before that
Dog experience	Categorical variable. Owners indicated how many dogs they had had living in their household.	This dog is the owner's first dog This dog is the owner's second dog This dog is the owner's third to fifth dog This dog is the owner's over fifth dog

Table S3. Socialisation item loadings**,** related to STAR Methods.

Item	**Loading**
Met unfamiliar men	**0.83**
Met unfamiliar women	**0.85**
Met unfamiliar children	**0.46**
Met unfamiliar dogs	**0.71**
Visited city center	**0.64**
Travelled by car	**0.39**
Travelled by public transportation	**0.44**

Table S4. Results of model validation in trait Insecurity, related to STAR Methods. Chosen explanatory variables are in bold.

Insecurity	**% present in random subsampling**	**% present in repeated train-test**	**relative influence**
sex	base	base	3.00
age	base	base	14.60
breed/breed group	base	base	33.60
level of socialisation	100	100	14.22
sterilisation status	100	100	8.77
dog experience	80	100	11.34
main reason/use	70	100	3.94
frequency of hobbies	60	100	4.69
living place	30	100	1.06
other dogs when acquired	30	100	0.67
other dogs currently	20	100	0.71
daily exercise	30	90	2.37
dog obtained from	10	70	1.03
average time spent alone	10	0	0.00
life experience of dogs	10	0	0.00
sex * sterilisation status	20	90	
age * sex	10	10	
life experience of dogs * dog experience	10	0	
main reason/use * frequency of hobbies	10	0	
daily exercise * frequency of hobbies	0	0	
living place * daily exercise	0	0	
other dogs currently * average time spent alone	0	0	
other dogs currently * other dogs when acquired	0	0	

Table S5. Results of model validation in trait Training focus, related to STAR Methods. Chosen explanatory variables are in bold.

Training focus	% present in random subsampling	% present in repeated train-test	relative influence
sex	base	base	2.20
age	base	base	34.68
breed/breed group	base	base	24.27
frequency of hobbies	80	100	11.63
daily exercise	70	100	4.29
level of socialisation	60	100	8.83
sterilisation status	60	100	3.22
average time spent alone	50	100	2.92
dog experience	50	100	2.88
main reason/use	30	100	3.34
dog obtained from	40	90	1.32
living place	20	40	0.42
other dogs when acquired	10	0	0.00
other dogs currently	10	0	0.00
life experience of dogs	0	0	0.00
living place * daily exercise	10	0	
main reason/use * frequency of hobbies	0	10	
sex * sterilisation status	0	0	
daily exercise * frequency of hobbies	0	0	
age * sex	0	0	
life experience of dogs * dog experience	0	0	
other dogs currently * average time spent alone	0	0	
other dogs currently * other dogs when acquired	0	0	

Table S6. Results of model validation in trait Energy, related to STAR Methods. Chosen explanatory variables are in bold.

Energy	% present in random subsampling	% present in repeated train-test	relative influence
sex	base	base	0.51
age	base	base	44.27
breed/breed group	base	base	46.82
frequency of hobbies	80	100	2.31
other dogs when acquired	60	100	2.14
other dogs currently	40	100	1.35
average time spent alone	30	90	0.57
daily exercise	10	20	0.24
dog experience	10	10	0.15
living place	10	0	0.00
level of socialisation	0	90	0.87
main reason/use	0	90	0.59
dog obtained from	0	20	0.15
life experience of dogs	0	0	0.03
sterilisation status	0	0	0.00
other dogs currently * other dogs when acquired	40	90	
sex * sterilisation status	0	0	
daily exercise * frequency of hobbies	0	0	
age * sex	0	0	
living place * daily exercise	0	0	
life experience of dogs * dog experience	0	0	
main reason/use * frequency of hobbies	0	0	
other dogs currently * average time spent alone	0	0	

Table S7. Results of model validation in trait Aggressiveness/dominance, related to STAR Methods. Chosen explanatory variables are in bold.

Aggressiveness/dominance	**% present in random subsampling**	**% present in repeated train-test**	**relative influence**
sex	base	base	6.06
age	base	base	34.78
breed/breed group	base	base	55.04
level of socialisation	50	100	2.64
dog obtained from	30	50	0.18
living place	20	50	0.15
other dogs when acquired	20	50	0.00
sterilisation status	10	50	0.37
main reason/use	10	60	0.12
average time spent alone	10	10	0.11
other dogs currently	10	10	0.00
daily exercise	0	50	0.33
dog experience	0	10	0.16
life experience of dogs	0	10	0.06
frequency of hobbies	0	0	0.00
age * sex	10	0	
sex * sterilisation status	0	0	
daily exercise * frequency of hobbies	0	0	
living place * daily exercise	0	0	
life experience of dogs * dog experience	0	0	
main reason/use * frequency of hobbies	0	0	
other dogs currently * average time spent alone	0	0	
other dogs currently * other dogs when acquired	0	0	

Table S8. Results of model validation in trait Human sociability, related to STAR Methods. Chosen explanatory variables are in bold.

Human sociability	**% present in random subsampling**	**% present in repeated train-test**	**relative influence**
sex	base	base	0.92
age	base	base	14.48
breed/breed group	base	base	68.00
main reason/use	60	100	6.82
level of socialisation	50	100	4.27
sterilisation status	30	70	1.02
living place	10	20	0.42
other dogs currently	10	10	0.02
life experience of dogs	10	0	0.00
dog experience	0	40	1.57
average time spent alone	0	40	1.37
frequency of hobbies	0	70	0.95
daily exercise	0	0	0.09
dog obtained from	0	10	0.08
other dogs when acquired	0	10	0.00
main reason/use * frequency of hobbies	0	60	
sex * sterilisation status	0	10	
daily exercise * frequency of hobbies	0	0	
age * sex	0	0	
living place * daily exercise	0	0	
life experience of dogs * dog experience	0	0	
other dogs currently * average time spent alone	0	0	
other dogs currently * other dogs when acquired	0	0	

Table S9. Results of model validation in trait Dog sociability, related to STAR Methods. Chosen explanatory variables are in bold.

Dog sociability	**% present in random subsampling**	**% present in repeated train-test**	**relative influence**
sex	base	base	4.37
age	base	base	79.66
breed/breed group	base	base	11.74
level of socialisation	50	100	0.70
main reason/use	30	100	0.41
sterilisation status	40	90	0.91
dog experience	40	70	0.82
daily exercise	40	80	0.58
other dogs currently	30	70	0.23
frequency of hobbies	20	30	0.19
life experience of dogs	20	10	0.02
dog obtained from	10	80	0.26
average time spent alone	10	30	0.07
living place	10	0	0.02
other dogs when acquired	10	10	0.00
sex * sterilisation status	10	70	
age * sex	10	0	
other dogs currently * other dogs when acquired	0	10	
life experience of dogs * dog experience	0	10	
daily exercise * frequency of hobbies	0	0	
living place * daily exercise	0	0	
main reason/use * frequency of hobbies	0	0	
other dogs currently * average time spent alone	0	0	

Table S10. Results of model validation in trait Perseverance, related to STAR Methods. Chosen explanatory variables are in bold.

Perseverance	**% present in random subsampling**	**% present in repeated train-test**	**relative influence**
sex	base	base	0.00
age	base	base	8.54
breed/breed group	base	base	62.69
main reason/use	80	100	7.86
other dogs when acquired	60	100	7.42
frequency of hobbies	40	100	5.60
other dogs currently	20	100	3.53
dog experience	20	40	2.21
daily exercise	20	30	0.67
level of socialisation	20	40	0.36
sterilisation status	10	30	0.56
life experience of dogs	10	10	0.22
dog obtained from	10	0	0.00
average time spent alone	0	0	0.34
living place	0	0	0.00
age * sex	20	0	
other dogs currently * other dogs when acquired	0	10	
sex * sterilisation status	0	0	
daily exercise * frequency of hobbies	0	0	
living place * daily exercise	0	0	
life experience of dogs * dog experience	0	0	
main reason/use * frequency of hobbies	0	0	
other dogs currently * average time spent alone	0	0	

Table S11. Range, mean and standard deviation (SD) of continuous variables, related to STAR Methods.

Variable	Range	Mean	SD
Age	0.18 - 17.13	5.18	3.44
Insecurity score	-1.65 - 4.04	-0.02	0.99
Training focus score	-5.10 - 2.48	0.01	1.00
Energy score	-3.94 - 2.10	-0.01	1.00
Aggressiveness/dominance score	-1.56 - 4.00	0.00	0.99
Human sociability score	-4.91 - 1.83	-0.01	1.00
Dog sociability score	-3.18 - 2.28	0.01	0.99
Perseverance score	-4.16 - 3.80	-0.01	0.99

Table S12. Categorical variables, their levels, and frequencies, related to STAR Methods.

Variable	Level	Freq	%
Breed/breed group	Asian primitive dogs	231	2.02
	Australian Shepherd	277	2.43
	Belgian shepherd dogs	197	1.73
	Bernese Mountain Dogs	155	1.36
	Bichon type dogs	201	1.76
	Border Collie	452	3.96
	Brachycephalic dogs	171	1.5
	Bull type terriers	169	1.48
	Chinese Crested Dog	123	1.08
	Dachshunds	154	1.35
	English herders	200	1.75
	European sighthounds	190	1.66
	Fighting dogs	153	1.34
	Finnish Lapponian Dog	480	4.2
	German Shepherd Dog	427	3.74
	German spitz related breeds	328	2.87
	Golden Retriever	187	1.64
	Hunting terriers	337	2.95
	Jack Russell Terrier	160	1.4
	Labrador Retriever	382	3.35
	Lagotto Romagnolo	184	1.61
	Lapponian Herder	177	1.55
	Livestock guardian dogs	96	0.84
	Mastiff type dogs	280	2.45
	Middle European herders	240	2.1
	Middle European utility dogs	385	3.37
	Miniature Pinscher	132	1.16
	Miniature Schnauzer	161	1.41
	Mixed breed	382	3.35
	Northern companion spitzes	179	1.57
	Northern hunting spitzes	143	1.25
	Nova Scotia Duck Tolling Retriever	123	1.08
	Other breed	86	0.75
	Other companion dogs	278	2.43
	Parson type terriers	151	1.32
	Pinschers/Schnauzers	144	1.26
	Pointers	254	2.22
	Poodles	232	2.03
	Primitive sighthounds	310	2.72
	Retrievers/Flushing dogs	462	4.05
	Rough Collie	179	1.57
	Scenthounds	90	0.79
	Schapendoes	102	0.89

	Shetland Sheepdog	280	2.45
	Sled dogs	147	1.29
	Smooth Collie	141	1.23
	Spanish Water Dog	226	1.98
	Teacup dogs	129	1.13
	Welsh Corgis	130	1.14
	Whippet	170	1.49
	White Swiss Shepherd Dog	150	1.31
	Yard terriers	301	2.64
Sex	Female	6039	52.89
	Male	5379	47.11
Sterilisation status	Intact	8677	75.99
	Neutered	2741	24.01
Main reason for ownership/use of the dog	Family member	7072	61.94
	Dog hobbies/work	2487	21.78
	Pet	1859	16.28
Obtained from	Born at owner's home	884	7.74
	From a breeder	9743	85.33
	Rescue/from a previous owner	791	6.93
Level of socialisation	Q1 (poor)	2410	21.11
	Q2	2430	21.28
	Q3	2417	21.17
	Q4 (best)	2417	21.17
	Obtained after the socialisation period	1744	15.27
Living place	Rural	2991	26.20
	Urban	8427	73.80
Other dogs in the household when acquired	Yes	6781	59.39
	No	4637	40.61
Other dogs in the household currently	Yes	7633	66.85
	No	3785	33.15
Daily exercise	Under 1 hour	1708	14.96
	1-2 hours	5619	49.21
	2-3 hours	3464	30.34
	Over 3 hours	627	5.49
Frequency of hobbies	Active	2853	24.99
	Active only at home	1428	12.51
	Active only outside	677	5.93
	Infrequent	1204	10.54
	Never/no hobby	5256	46.03
Average time spent alone	Under 1 hour	1341	11.74
	1-3 hours	1814	15.89
	3-6 hours	3072	26.90
	6-8 hours	3063	26.83
	Over 8 hours	2128	18.64
Life experience of dogs	Family dog(s) in childhood	7232	63.34

	Family dog(s) during adolescence	1333	11.67
	First dog in adulthood	2853	24.99
Dog experience	First dog	2477	21.69
	Second dog	2175	19.05
	3-5th dog	4459	39.05
	Over 5th dog	2307	20.20

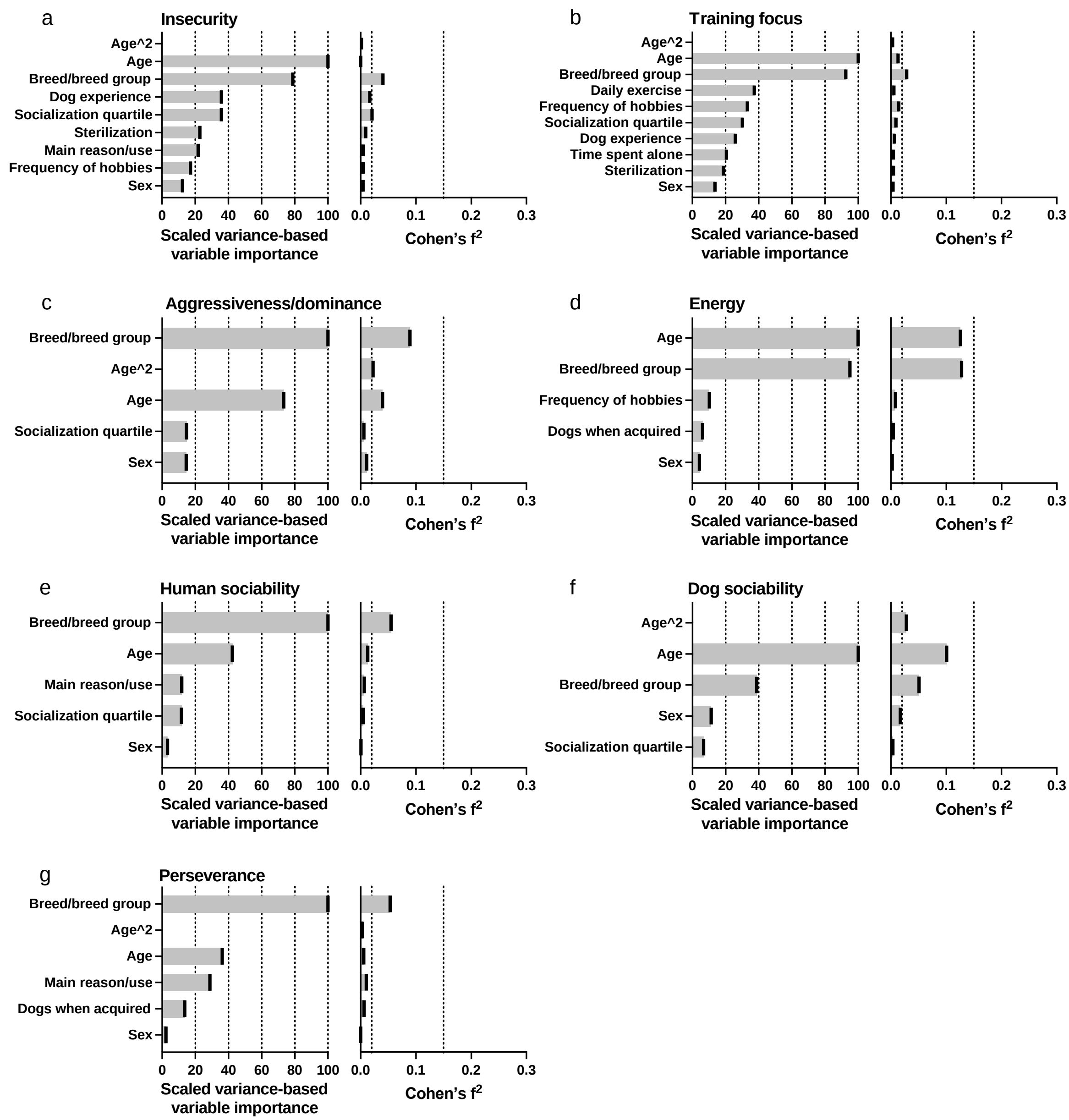

Fig. S1. Scaled variance-based variable importance (relative effect size) and Cohen's f^2 (absolute effect size) of explanatory variables, related to Figure1. a) insecurity, b) training focus, c) aggressiveness/dominance, d) energy, e) human sociability, f) dog sociability, and g) perseverance. In Cohen's f^2, lines (0.02 and 0.15) indicate small and medium effect sizes. Age^2 = age as a quadratic explanatory variable.

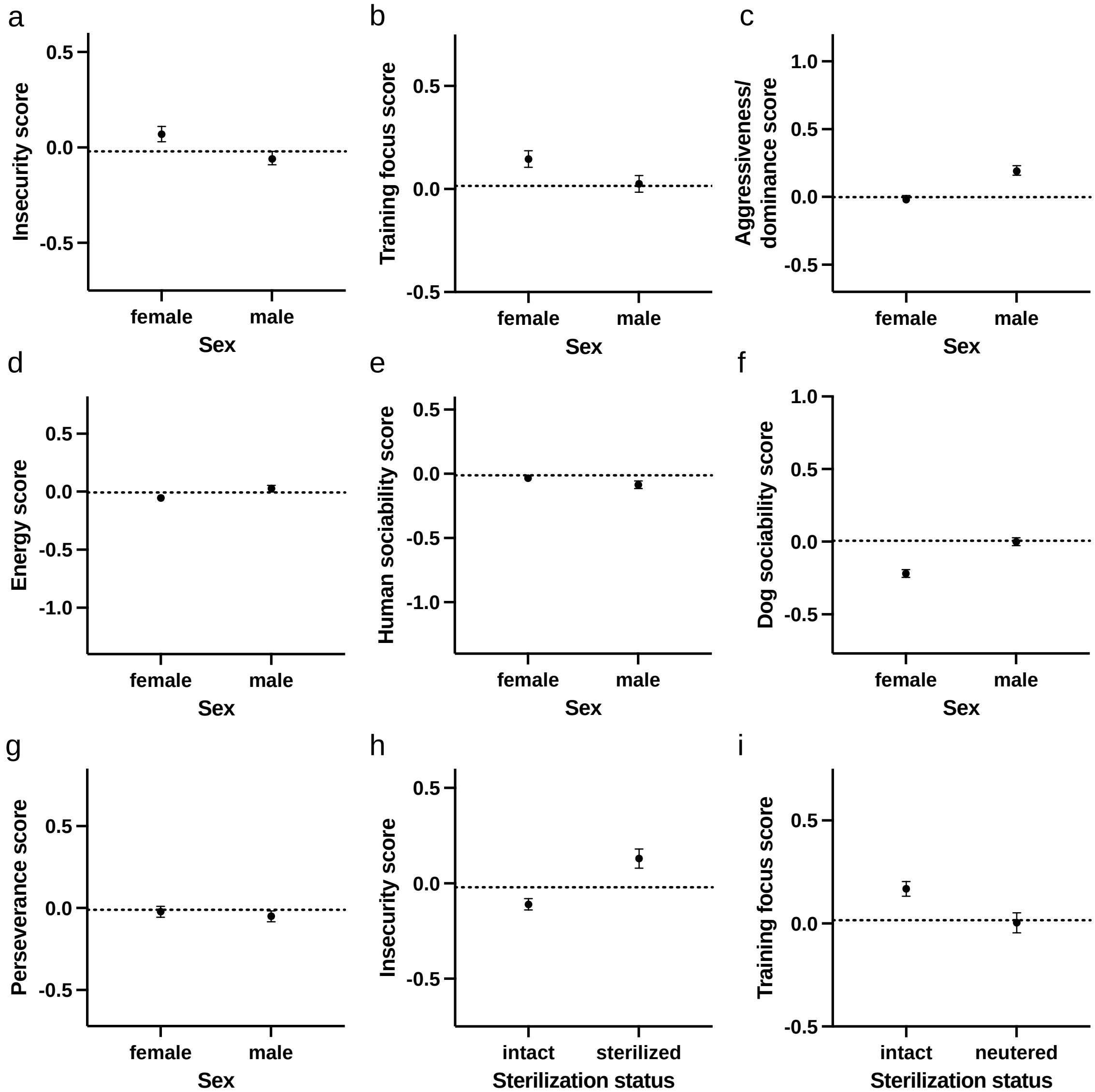

Fig. S2. Association of sex and sterilisation status with personality in the general and generalised linear models, related to Table 1**.** Association of sex with a) insecurity, b) training focus, c) aggressiveness/dominance, d) energy, e) human sociability, f) dog sociability, and g) perseverance and association of sterilisation status with h) insecurity and i) training focus. Error bars indicate 95% confidence limits. N = 11 418.

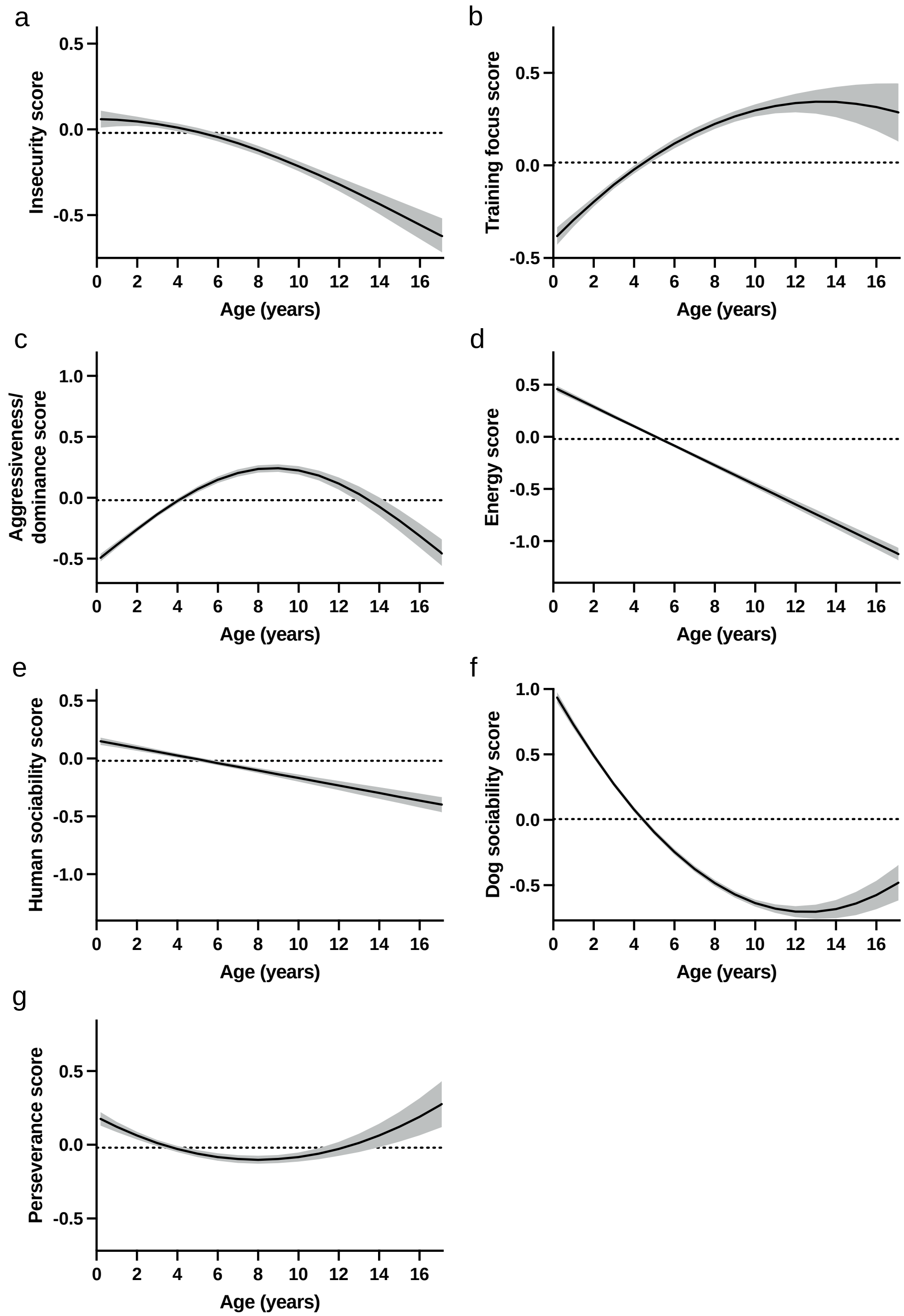

Fig. S3. Association of age with personality in general and generalized linear models, related to Table 1. A) insecurity, b) training focus, c) aggressiveness/dominance, d) energy, e) human sociability, f) dog sociability, and g) perseverance. Grey areas indicate 95% confidence limits. N = 11 418.

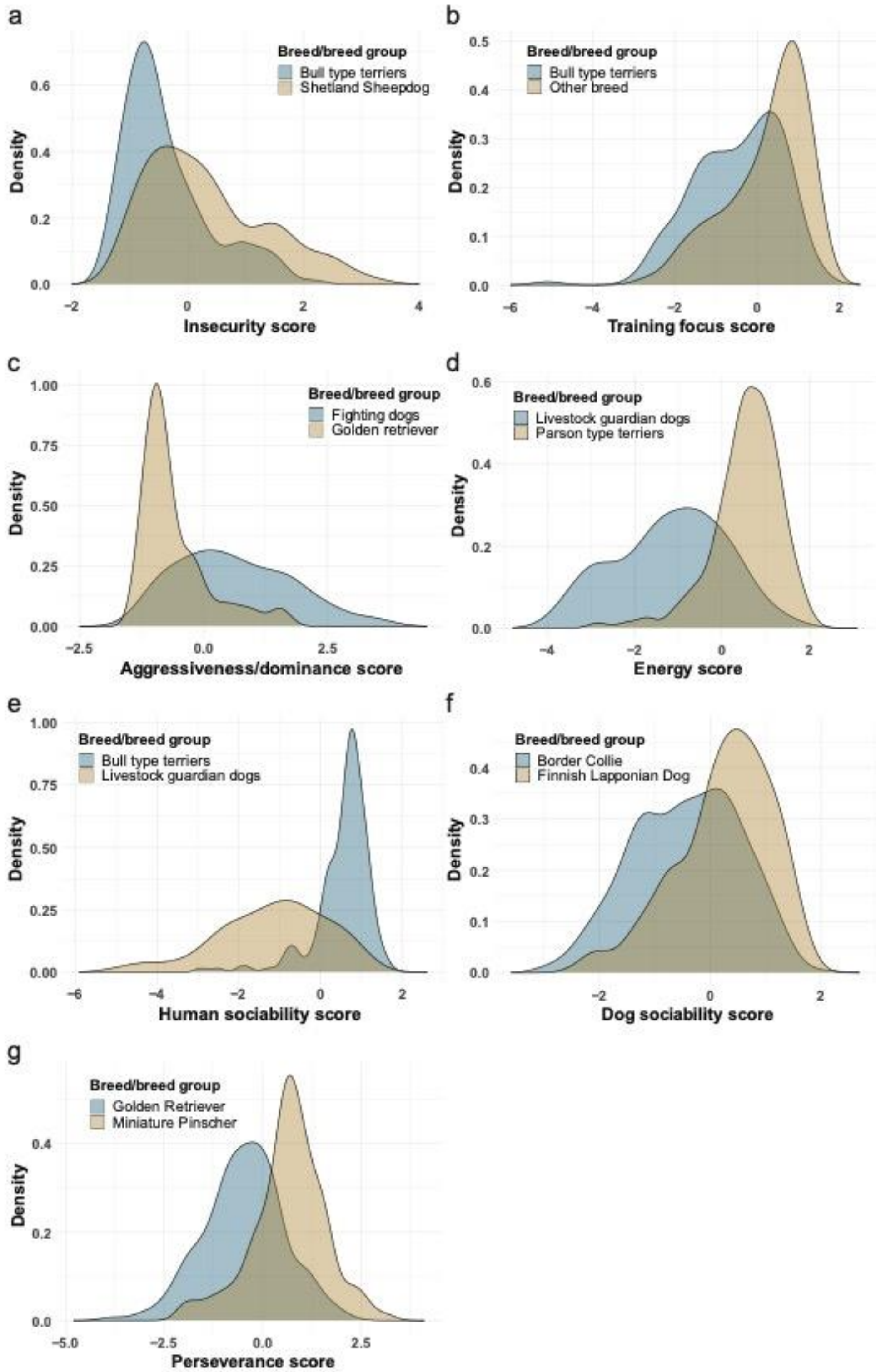

Fig. S4. Trait score distribution of the breeds with the highest and lowest mean scores in personality, related to Table 1. a) Insecurity, b) training focus, c) aggressiveness/dominance, d) energy, e) human sociability, f) dog sociability, and g) perseverance.

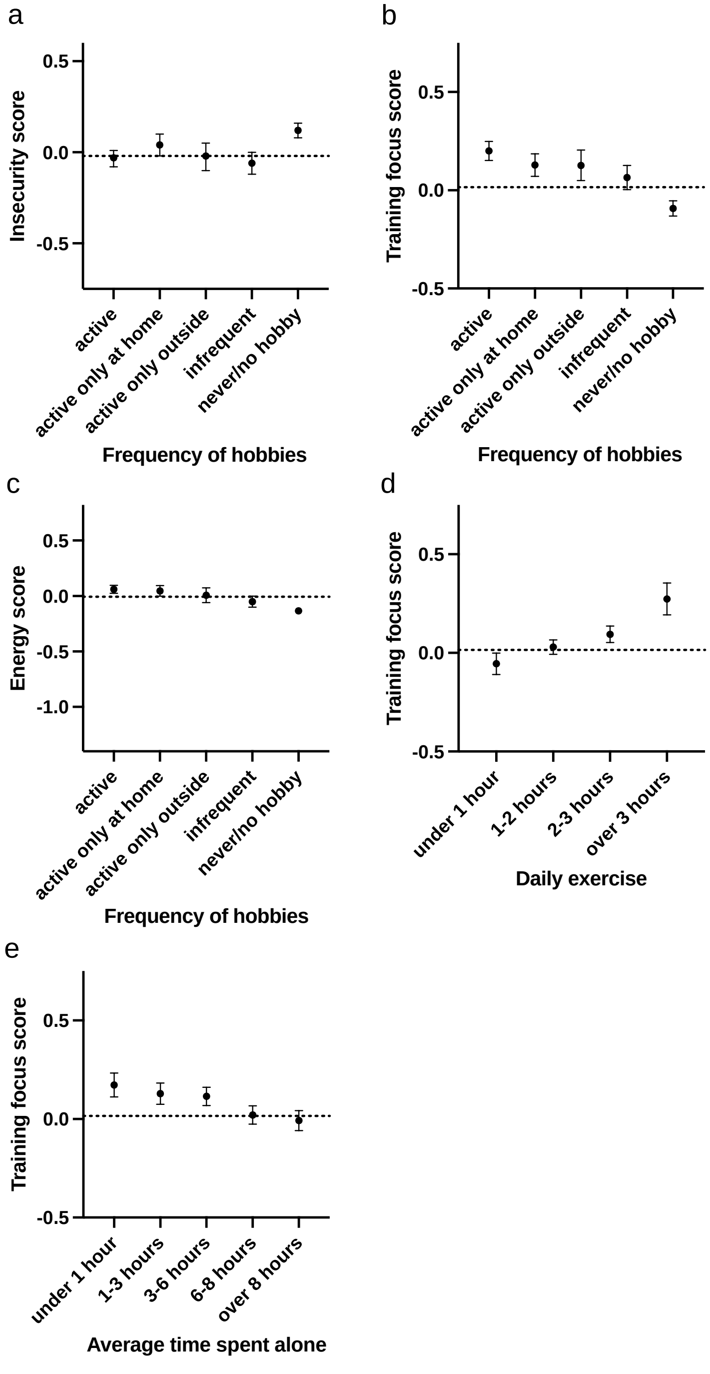

Fig. S5. Association of frequency of hobbies, daily exercise, and average time spent alone with personality in the general and generalised linear models, related to Table 1. Association of frequency of hobbies with a) insecurity, b) training focus, and c) energy and association of d) daily exercise and e) average time spent alone with training focus. Error bars indicate 95% confidence limits. N = 11 418.

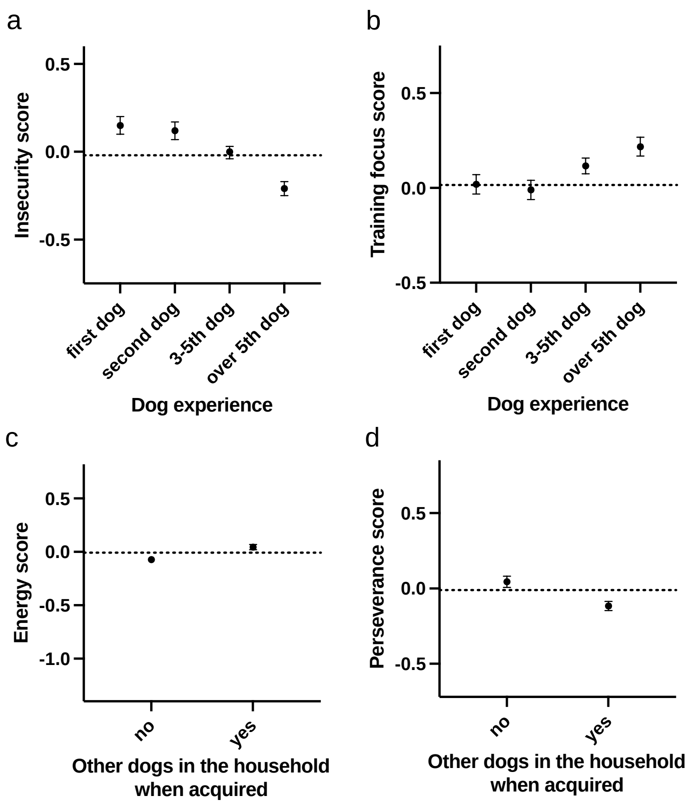

Fig. S6. Association of dog experience and other dogs in the household with personality in the general and generalised linear models, related to Table 1. Association of dog experience with a) insecurity and b) training focus and association of other dogs in the household when acquired with c) energy and d) perseverance. Error bars indicate 95% confidence limits. N = 11 418.

Data S1. R code, related to STAR Methods.

```
#### DATA ####

pers.envi.small


#### 10-FOLD CV AIC MODEL SELECTION ####

library(airGLMs)

# split into 10 equal portions
set.seed(42)
osiot <- split(pers.envi.small, sample(rep(1:10)))

# model selection
airglm.1 <- airglms(config.1,score="AIC",verbose=T, sort="score")
airglm.2 <- airglms(config.2,score="AIC",verbose=T, sort="score")
airglm.3 <- airglms(config.3,score="AIC",verbose=T, sort="score")
airglm.4 <- airglms(config.4,score="AIC",verbose=T, sort="score")
airglm.5 <- airglms(config.5,score="AIC",verbose=T, sort="score")
airglm.6 <- airglms(config.6,score="AIC",verbose=T, sort="score")
airglm.7 <- airglms(config.7,score="AIC",verbose=T, sort="score")
airglm.8 <- airglms(config.8,score="AIC",verbose=T, sort="score")
airglm.9 <- airglms(config.9,score="AIC",verbose=T, sort="score")
airglm.10 <- airglms(config.10,score="AIC",verbose=T, sort="score")



#### REPEATED 2-FOLD ####

library(caret)
library(airGLMs)

# setting seed to generate a
# reproducible random sampling
set.seed(42)
twoK.five.folds <- createMultiFolds(pers.envi.small$dog.id, k = 2, times = 5)
twoK.five.data <- lapply(twoK.five.folds, function(ind, dat) dat[ind,], dat = pers.envi.small)

# model selection
airglm.1 <- airglms(config.1,score="AIC",verbose=T, sort="score")
airglm.2 <- airglms(config.2,score="AIC",verbose=T, sort="score")
airglm.3 <- airglms(config.3,score="AIC",verbose=T, sort="score")
airglm.4 <- airglms(config.4,score="AIC",verbose=T, sort="score")
airglm.5 <- airglms(config.5,score="AIC",verbose=T, sort="score")
airglm.6 <- airglms(config.6,score="AIC",verbose=T, sort="score")
airglm.7 <- airglms(config.7,score="AIC",verbose=T, sort="score")
airglm.8 <- airglms(config.8,score="AIC",verbose=T, sort="score")
airglm.9 <- airglms(config.9,score="AIC",verbose=T, sort="score")
airglm.10 <- airglms(config.10,score="AIC",verbose=T, sort="score")


#### IMPORTANCE OF VARIABLES: PACKAGE GBM ####

library(gbm)


#### *** insecurity ####
```

```r
insec.data = pers.envi.small[c(3:14,16,24,26:27)]
colnames(insec.data)

set.seed(42)
gbm.insecurity <- gbm(formula = insecurity_score_add ~. ,
                      distribution = "gaussian", data = insec.data,
                      n.trees = 10000, interaction.depth = 1, shrinkage = 0.1,
                      bag.fraction = 0.5, cv.folds = 10)
print(gbm.insecurity)

# plot loss function as a result of n trees added to the ensemble
gbm.perf(gbm.insecurity, method = "cv")

# get MSE and compute RMSE
sqrt(min(gbm.insecurity$cv.error))

# influence of variables
# from the first analysis
set.seed(42)
summary(gbm.insecurity, method=permutation.test.gbm)



#### *** training focus ####

train.data = pers.envi.small[c(3:14,16,18,26:27)]
colnames(train.data)

set.seed(42)
gbm.train <- gbm(formula = training_focus_score ~. ,
                 distribution = "gaussian", data = train.data,
                 n.trees = 10000, interaction.depth = 1, shrinkage = 0.1,
                 bag.fraction = 0.5, cv.folds = 10)
print(gbm.train)

# plot loss of function as a result of n trees added to the ensemble
gbm.perf(gbm.train, method = "cv")

# get MSE and compute RMSE
sqrt(min(gbm.train$cv.error))

# influence of variables
set.seed(42)
summary(gbm.train, method=permutation.test.gbm)


#### *** energy ####

energy.data = pers.envi.small[c(3:14,16,19,26:27)]
colnames(energy.data)

set.seed(42)
gbm.energy <- gbm(formula = activity_playfulness_score ~. ,
                  distribution = "gaussian", data = energy.data,
                  n.trees = 10000, interaction.depth = 1, shrinkage = 0.1,
                  bag.fraction = 0.5, cv.folds = 10)
print(gbm.energy)

# plot loss of function as a result of n trees added to the ensemble
```

```
gbm.perf(gbm.energy, method = "cv")

# get MSE and compute RMSE
sqrt(min(gbm.energy$cv.error))

# influence of variables
set.seed(42)
summary(gbm.energy, method=permutation.test.gbm)


#### *** aggression/dominance ####

domin.data = pers.envi.small[c(3:14,16,25,26:27)]
colnames(domin.data)

set.seed(42)
gbm.domin <- gbm(formula = aggressiveness_dominance_score_add ~. ,
                 distribution = "gaussian", data = domin.data,
                 n.trees = 10000, interaction.depth = 1, shrinkage = 0.1,
                 bag.fraction = 0.5, cv.folds = 10)
print(gbm.domin)

# plot loss of function as a result of n trees added to the ensemble
gbm.perf(gbm.domin, method = "cv")

# get MSE and compute RMSE
sqrt(min(gbm.domin$cv.error))

# influence of variables
set.seed(42)
summary(gbm.domin, method=permutation.test.gbm)


#### *** human sociability ####

humsoc.data <- pers.envi.small[c(3:14,16,21,26:27)]
colnames(humsoc.data)

set.seed(42)
gbm.humsoc <- gbm(formula = human_sociability_score ~. ,
                  distribution = "gaussian", data = humsoc.data,
                  n.trees = 10000, interaction.depth = 1, shrinkage = 0.1,
                  bag.fraction = 0.5, cv.folds = 10)
print(gbm.humsoc)

# plot loss of function as a result of n trees added to the ensemble
gbm.perf(gbm.humsoc, method = "cv")

# get MSE and compute RMSE
sqrt(min(gbm.humsoc$cv.error))

# influence of variables
set.seed(42)
summary(gbm.humsoc, method=permutation.test.gbm)



#### *** dog sociability ####
```

```
dogsoc.data <- pers.envi.small[c(3:14,16,22,26:27)]
colnames(dogsoc.data)

set.seed(42)
gbm.dogsoc <- gbm(formula = dog_sociability_score ~. ,
                  distribution = "gaussian", data = dogsoc.data,
                  n.trees = 10000, interaction.depth = 1, shrinkage = 0.1,
                  bag.fraction = 0.5, cv.folds = 10)
print(gbm.dogsoc)

# plot loss of function as a result of n trees added to the ensemble
gbm.perf(gbm.dogsoc, method = "cv")

# get MSE and compute RMSE
sqrt(min(gbm.dogsoc$cv.error))

# influence of variables
set.seed(42)
summary(gbm.dogsoc, method=permutation.test.gbm)



#### *** perseverance ####

perseverance.data <- pers.envi.small[c(3:14,16,23,26:27)]
colnames(perseverance.data)

set.seed(42)
gbm.perseverance <- gbm(formula = perseverance_score ~. ,
                        distribution = "gaussian", data = perseverance.data,
                        n.trees = 10000, interaction.depth = 1, shrinkage = 0.1,
                        bag.fraction = 0.5, cv.folds = 10)
print(gbm.perseverance)

# plot loss of function as a result of n trees added to the ensemble
gbm.perf(gbm.perseverance, method = "cv")

# get MSE and compute RMSE
sqrt(min(gbm.perseverance$cv.error))

# influence of variables
set.seed(42)
summary(gbm.perseverance, method=permutation.test.gbm)





#### GLM MODELS ####

#### ** MODEL FIT ####

# for plotting residuals
library(rcompanion)
library (boot)

# for outliers
library(broom)
library(dplyr)
```

```r
library(ggplot2)

# for checking the linearity assumption
library(gam)

# for multicollinnearity
library(car)

# for autocorrelation of residuals
library(lmtest)




#### ***** insecurity ####

insecurity.model <- glm(insecurity_score_add ~ sex + Personality_age +
                          breed_group + socialization_quantile +
                          sterilization_status + dog_experience +
                          ownership_reason + hobby_frequency,
                        data=pers.envi.small, family=Gamma(link="log"))

# residuals: really good
plotNormalHistogram(residuals(insecurity.model))
glm.diag.plots(insecurity.model)

# linearity of age
gam.insec <- gam(formula = insecurity_score_add ~ sex + s(Personality_age) +
                   s(I(Personality_age^2)) +
                   breed_group + socialization_quantile +
                   sterilization_status + dog_experience +
                   ownership_reason + hobby_frequency,
                 data=pers.envi.small,
                 family=Gamma(link="log"))
# nonlinearity detected
# with age^2 nicely linear
summary(gam.insec)
plot(gam.insec)

# influential data points
# plot with three most influential labelled
plot(insecurity.model, which = 4, id.n = 3)

# compute standardized residuals
model.data <- augment(insecurity.model) %>%
  mutate(index = 1:n())
# display the data points with the highest Cook's distances
options(tibble.width = Inf)
options(max.print = 10000)
model.data %>% top_n(3, .cooksd)
# and with highest and lowest std. resid
model.data %>% top_n(3, .std.resid)
model.data %>% top_n(-5, .std.resid)
# visualize the standardized residuals
ggplot(model.data, aes(index, .std.resid)) +
  geom_point(aes(color = insecurity_score_add), alpha = .5) +
  theme_bw()

# removed and refitted
pers.envi.small[c(6017,7092,7779,7884,8858,9224,9282,11141,11293),]
```

```r
insec.test <- pers.envi.small[-c(6017,7092,7779,7884,8858,9224,9282,11141,11293),]

insecurity.model.test <- glm(insecurity_score_add ~ sex + Personality_age +
                               breed_group + socialization_quantile +
                               sterilization_status + dog_experience +
                               ownership_reason + hobby_frequency,
                           data=insec.test, family=Gamma(link="log"))
# doesn't influence results and thus, kept in the model
summary(insecurity.model)
summary(insecurity.model.test)

# multicollinearity
# no multicollinearity
vif(insecurity.model)

# autocorrelation of residuals
# no autocorrelation
dwtest(insecurity.model)




#### ***** training focus ####

training.model <- glm(training_focus_score ~ sex + Personality_age +
                        breed_group + hobby_frequency + daily_exercise +
                        socialization_quantile + sterilization_status +
                        alone_time + dog_experience,
                        data=pers.envi.small, family=gaussian(link="identity"))

# residuals: could be improved
plotNormalHistogram(residuals(training.model))
glm.diag.plots(training.model)

# let's fit Gamma model
pers.envi.small$training_focus_add <- pers.envi.small$training_focus_score + 5.3
training.gamma <- glm(training_focus_add ~ sex + Personality_age +
                        breed_group + hobby_frequency + daily_exercise +
                        socialization_quantile + sterilization_status +
                        alone_time + dog_experience,
                      data=pers.envi.small, family=Gamma(link="log"))
# residuals of Gamma model: worse
plotNormalHistogram(residuals(training.gamma))
glm.diag.plots(training.gamma)
# so we'll continue with normal distribution

# linearity of age
gam.train <- gam(formula = training_focus_score ~ sex + s(Personality_age) +
                   s(I(Personality_age^2)) +
                   breed_group + hobby_frequency + daily_exercise +
                   socialization_quantile + sterilization_status +
                   alone_time + dog_experience,
                 data=pers.envi.small,
                 family=gaussian(link="identity"))
# nonlinearity detected
# with age^2 somewhat linear
summary(gam.train)
plot(gam.train)

# influential data points
```

```
# plot with three most influential labelled
plot(training.model, which = 4, id.n = 3)

# compute standardized residuals
model.data <- augment(training.model) %>%
  mutate(index = 1:n())
# display the data points with the highest Cook's distances
options(tibble.width = Inf)
options(max.print = 10000)
model.data %>% top_n(3, .cooksd)
# and with highest and lowest std. resid
model.data %>% top_n(3, .std.resid)
model.data %>% top_n(-6, .std.resid)
# visualize the standardized residuals
ggplot(model.data, aes(index, .std.resid)) +
  geom_point(aes(color = training_focus_score), alpha = .5) +
  theme_bw()

# removed and refitted
train.test <- pers.envi.small[-c(1203,4440,5957,7905,11294,11379),]

training.model.test <- glm(training_focus_score ~ sex + Personality_age +
                             breed_group + hobby_frequency + daily_exercise +
                             socialization_quantile + sterilization_status +
                             alone_time + dog_experience,
                         data=train.test, family=gaussian(link="identity"))
# doesn't influence results and thus, kept in the model
summary(training.model)
summary(training.model.test)

# multicollinearity
# no multicollinearity
vif(training.model)

# autocorrelation of residuals
# test sigificant, but DW=1.92 = no autocorrelation
dwtest(training.model)




#### ***** energy ####

energy.model <- glm(activity_playfulness_score ~ sex + Personality_age +
                      breed_group + hobby_frequency + dogs_acquired,
                    data=pers.envi.small, family=gaussian(link="identity"))

# residuals: very good
plotNormalHistogram(residuals(energy.model))
glm.diag.plots(energy.model)


# linearity of age
gam.energy <- gam(formula = activity_playfulness_score ~ sex + s(Personality_age) +
                    s(I(Personality_age^2)) +
                    breed_group + hobby_frequency + dogs_acquired,
                 data=pers.envi.small,
                 family=gaussian(link="identity"))
# no nonlinearity, but let's test age^2
# with age^2 worse
```

```
# so let's keep it this way
summary(gam.energy)
plot(gam.energy)

# influential data points
# plot with three most influential labelled
plot(energy.model, which = 4, id.n = 3)

# compute standardized residuals
model.data <- augment(energy.model) %>%
  mutate(index = 1:n())
# display the data points with the highest Cook's distances
options(tibble.width = Inf)
options(max.print = 10000)
model.data %>% top_n(3, .cooksd)
# and with highest and lowest std. resid
model.data %>% top_n(3, .std.resid)
model.data %>% top_n(-6, .std.resid)
# visualize the standardized residuals
ggplot(model.data, aes(index, .std.resid)) +
  geom_point(aes(color = activity_playfulness_score), alpha = .5) +
  theme_bw()

# removed and refitted
energy.test <- pers.envi.small[-c(711,2886,3352,3917,4355,5230,6905,7123,8667,11403),]

energy.model.test <- glm(activity_playfulness_score ~ sex + Personality_age +
                           breed_group + hobby_frequency + dogs_acquired,
                           data=energy.test, family=gaussian(link="identity"))
# doesn't influence results and thus, kept in the model
summary(energy.model)
summary(energy.model.test)

# multicollinearity
# no multicollinearity
vif(energy.model)

# autocorrelation of residuals
# no autocorrelation
dwtest(energy.model)




#### ***** dominance ####

dominance.model <- glm(aggressiveness_dominance_score_add ~ sex +
                         Personality_age + breed_group +
                         socialization_quantile,
                        data=pers.envi.small, family=Gamma(link="log"))

# residuals: really good
plotNormalHistogram(residuals(dominance.model))
glm.diag.plots(dominance.model)

# linearity of age
gam.domin <- gam(formula = aggressiveness_dominance_score_add ~ sex +
                   s(Personality_age) + s(I(Personality_age^2)) +
                   breed_group + socialization_quantile,
                 data=pers.envi.small,
```

```
                 family=Gamma(link="log"))
# very high nonlinearity
# with age^2 nicely linear
summary(gam.domin)
plot(gam.domin)

# influential data points
# plot with three most influential labelled
plot(dominance.model, which = 4, id.n = 3)

# compute standardized residuals
model.data <- augment(dominance.model) %>%
  mutate(index = 1:n())
# display the data points with the highest Cook's distances
options(tibble.width = Inf)
options(max.print = 10000)
model.data %>% top_n(3, .cooksd)
# and with highest and lowest std. resid
model.data %>% top_n(3, .std.resid)
model.data %>% top_n(-6, .std.resid)
# visualize the standardized residuals
ggplot(model.data, aes(index, .std.resid)) +
  geom_point(aes(color = aggressiveness_dominance_score_add), alpha = .5) +
  theme_bw()

# removed and refitted
domin.test <- pers.envi.small[-c(853,1908,3834,4099,5267,8212,8293,8596,10925),]

dominance.model.test <- glm(aggressiveness_dominance_score_add ~ sex +
                              Personality_age + breed_group +
                              socialization_quantile,
                             data=domin.test, family=Gamma(link="log"))
# doesn't influence results and thus, kept in the model
summary(dominance.model)
summary(dominance.model.test)

# multicollinearity
# no multicollinearity
vif(dominance.model)

# autocorrelation of residuals
# no autocorrelation
dwtest(dominance.model)




#### ***** human sociability ####

human.soc.model <- glm(human_sociability_score ~ sex +
                         Personality_age + breed_group +
                         ownership_reason + socialization_quantile,
                       data=pers.envi.small, family=gaussian(link="identity"))

# residuals: could be improved
plotNormalHistogram(residuals(human.soc.model))
glm.diag.plots(human.soc.model)
# gamma doesn't fit any better, so let's continue with normal
pers.envi.small$human_sociability_score_add <- pers.envi.small$human_sociability_score + 4.92
human.soc.model.gamma <- glm(human_sociability_score_add ~ sex +
```

```
                                Personality_age + breed_group +
                                ownership_reason + socialization_quantile,
                        data=pers.envi.small, family=Gamma(link="log"))
plotNormalHistogram(residuals(human.soc.model.gamma))
glm.diag.plots(human.soc.model.gamma)


# linearity of age
gam.hum.soc <- gam(formula = human_sociability_score ~ sex +
                     s(Personality_age) + s(I(Personality_age^2)) +
                     breed_group +
                     ownership_reason + socialization_quantile,
                  data=pers.envi.small,
                  family=gaussian(link="identity"))
# slight nonlinearity
# with age^2 worsened
# so let's keep it this way
summary(gam.hum.soc)
plot(gam.hum.soc)

# influential data points
# plot with three most influential labelled
plot(human.soc.model, which = 4, id.n = 3)

# compute standardized residuals
model.data <- augment(human.soc.model) %>%
  mutate(index = 1:n())
# display the data points with the highest Cook's distances
options(tibble.width = Inf)
options(max.print = 10000)
model.data %>% top_n(3, .cooksd)
# and with highest and lowest std. resid
model.data %>% top_n(3, .std.resid)
model.data %>% top_n(-10, .std.resid)
# visualize the standardized residuals
ggplot(model.data, aes(index, .std.resid)) +
  geom_point(aes(color = human_sociability_score), alpha = .5) +
  theme_bw()

# removed and refitted
hum.soc.test <- pers.envi.small[-c(1657,2476,3483,4850,5364,5576,5903,8305,8401,10198,11294),]

hum.soc.model.test <- glm(human_sociability_score ~ sex +
                            Personality_age + breed_group +
                            ownership_reason + socialization_quantile,
                          data=hum.soc.test, family=gaussian(link="identity"))
# doesn't influence results and thus, kept in the model
summary(human.soc.model)
summary(hum.soc.model.test)

# multicollinearity
# no multicollinearity
vif(human.soc.model)

# autocorrelation of residuals
# small p-value but DW = 1.94 = no autocorrelation
dwtest(human.soc.model)
```

```r
#### ***** dog sociability ####

dog.soc.model <- glm(dog_sociability_score ~ sex +
                        Personality_age + breed_group +
                        socialization_quantile,
                      data=pers.envi.small, family=gaussian(link="identity"))

# residuals: very good
plotNormalHistogram(residuals(dog.soc.model))
glm.diag.plots(dog.soc.model)

# linearity of age
gam.dog.soc <- gam(formula = dog_sociability_score ~ sex +
                     s(Personality_age) + s(I(Personality_age^2)) +
                     breed_group +
                     socialization_quantile,
                   data=pers.envi.small,
                   family=gaussian(link="identity"))
# nonlinearity detected
# with age^2 improved
summary(gam.dog.soc)
plot(gam.dog.soc)

# influential data points
# plot with three most influential labelled
plot(dog.soc.model, which = 4, id.n = 3)

# compute standardized residuals
model.data <- augment(dog.soc.model) %>%
  mutate(index = 1:n())
# display the data points with the highest Cook's distances
options(tibble.width = Inf)
options(max.print = 10000)
model.data %>% top_n(3, .cooksd)
# and with highest and lowest std. resid
model.data %>% top_n(3, .std.resid)
model.data %>% top_n(-6, .std.resid)
# visualize the standardized residuals
ggplot(model.data, aes(index, .std.resid)) +
  geom_point(aes(color = dog_sociability_score), alpha = .5) +
  theme_bw()

# removed and refitted
dog.soc.test <- pers.envi.small[-c(63,1148,2201,2509,3753,5624,7624,8248,8361,9187),]

dog.soc.model.test <- glm(dog_sociability_score ~ sex +
                            Personality_age + breed_group +
                            socialization_quantile,
                          data=dog.soc.test, family=gaussian(link="identity"))
# doesn't influence results and thus, kept in the model
summary(dog.soc.model)
summary(dog.soc.model.test)

# multicollinearity
# no multicollinearity
vif(dog.soc.model)

# autocorrelation of residuals
# small p-value but DW = 1.91 = no autocorrelation
dwtest(dog.soc.model)
```

```r
#### ***** perseverance ####

perseverance.model <- glm(perseverance_score ~ sex +
                            Personality_age +
                            breed_group + ownership_reason +
                            dogs_acquired,
                          data=pers.envi.small, family=gaussian(link="identity"))

# residuals: excellent
plotNormalHistogram(residuals(perseverance.model))
glm.diag.plots(perseverance.model)

# linearity of age
gam.perseverance <- gam(formula = perseverance_score ~ sex +
                          s(Personality_age) + s(I(Personality_age^2)) +
                          breed_group + ownership_reason +
                          dogs_acquired,
                   data=pers.envi.small,
                   family=gaussian(link="identity"))
# nonlinearity detected
# with age^2 improved
summary(gam.perseverance)
plot(gam.perseverance)

# influential data points
# plot with three most influential labelled
plot(perseverance.model, which = 4, id.n = 3)

# compute standardized residuals
model.data <- augment(perseverance.model) %>%
  mutate(index = 1:n())
# display the data points with the highest Cook's distances
options(tibble.width = Inf)
options(max.print = 10000)
model.data %>% top_n(3, .cooksd)
# and with highest and lowest std. resid
model.data %>% top_n(5, .std.resid)
model.data %>% top_n(-5, .std.resid)
# visualize the standardized residuals
ggplot(model.data, aes(index, .std.resid)) +
  geom_point(aes(color = perseverance_score), alpha = .5) +
  theme_bw()

# removed and refitted
perseverance.test <- pers.envi.small[-c(88,149,3144,3644,6428,6451,7036,8597,9798,11294),]

perseverance.model.test <- glm(perseverance_score ~ sex +
                                 Personality_age +
                                 breed_group + ownership_reason +
                                 dogs_acquired,
                          data=perseverance.test, family=gaussian(link="identity"))
# doesn't influence results and thus, kept in the model
summary(perseverance.model)
summary(perseverance.model.test)
```

```
# multicollinearity
# no multicollinearity
vif(perseverance.model)

# autocorrelation of residuals
# small p-value but DW = 1.91 = no autocorrelation
dwtest(perseverance.model)




#### ** RESULTS ####

# for Anova
library(car)

# for categorical variables
library(emmeans)

# for continuous variables
library(effects)

# for writing out pairwise results in .csv
library(erer)


#### outlier 11294 removed from data as it pops out in 3/7 ####

pers.envi.small.ed <- pers.envi.small[-11294,]
pers.envi.small[11294,]
nrow(pers.envi.small.ed)
summary(pers.envi.small.ed)

#### ***** insecurity ####

insecurity.model.final <- glm(insecurity_score_add ~ sex + Personality_age +
                                I(Personality_age^2) +
                                breed_group + socialization_quantile +
                                sterilization_status + dog_experience +
                                ownership_reason + hobby_frequency,
                             data=pers.envi.small.ed, family=Gamma(link="log"))

### anova with f test values
Anova(insecurity.model.final, type="III", test.statistic="F")

# glance of results
plot(allEffects(insecurity.model.final))


# emmeans objects
insec.sex <- emmeans(insecurity.model.final, "sex", type="response")
insec.breed <- emmeans(insecurity.model.final, "breed_group", type="response")
insec.socialization <- emmeans(insecurity.model.final, "socialization_quantile", type="respons
e")
insec.sterilization <- emmeans(insecurity.model.final, "sterilization_status", type="response"
)
insec.experience <- emmeans(insecurity.model.final, "dog_experience", type="response")
insec.reason <- emmeans(insecurity.model.final, "ownership_reason", type="response")
insec.hobby <- emmeans(insecurity.model.final, "hobby_frequency", type="response")
```

```
# pairwise differences
pairwise.contrasts <- list(pairs(insec.sex,adjust="none"),
                           pairs(insec.socialization,adjust="none"),
                           pairs(insec.sterilization,adjust="none"),
                           pairs(insec.experience,adjust="none"),
                           pairs(insec.reason,adjust="none"),
                           pairs(insec.hobby,adjust="none"),
                           pairs(insec.breed,adjust="none"))
write.list(pairwise.contrasts,file="pairwise.csv")

### age

insecurity.age <- Effect(focal.predictors = c("Personality_age"), mod = insecurity.model.final
,
                            xlevels=list(Personality_age=c(0.2,1,2,3,4,5,6,7,8,9,10,11,12,13,1
4,15,16,17,17.1)),
                         confint=TRUE)
mean.cl <- data.frame(insecurity.age$fit,insecurity.age$lower,insecurity.age$upper)
mean.cl.exp <- exp(mean.cl)
mean.cl.trans <- mean.cl.exp - 1.67

mean.cl.fin <- data.frame(insecurity.age$x,mean.cl.exp,mean.cl.trans)
mean.cl.fin





#### ***** training focus ####

training.model.final <- glm(training_focus_score ~ sex + Personality_age +
                              I(Personality_age^2) +
                              breed_group + hobby_frequency + daily_exercise +
                              socialization_quantile + sterilization_status +
                              alone_time + dog_experience,
                         data=pers.envi.small.ed, family=gaussian(link="identity"))
summary(training.model.final)
### anova with f test values
Anova(training.model.final, type="III", test.statistic="F")

# glance of results
plot(allEffects(training.model.final))

# reference grid for emmeans
training.grid <- ref_grid(training.model.final)
# save the reference grid
save(training.grid,file="training-grid-final.RData")

train.sex <- emmeans(training.grid, "sex", type="response")
train.breed <- emmeans(training.grid, "breed_group", type="response")
train.hobby <- emmeans(training.grid, "hobby_frequency", type="response")
train.exercise <- emmeans(training.grid, "daily_exercise", type="response")
train.socialization <- emmeans(training.grid, "socialization_quantile", type="response")
train.sterilization <- emmeans(training.grid, "sterilization_status", type="response")
train.alone <- emmeans(training.grid, "alone_time", type="response")
train.experience <- emmeans(training.grid, "dog_experience", type="response")
```

```
# pairwise differences
pairwise.contrasts <- list(pairs(train.sex,adjust="none"),
                           pairs(train.hobby,adjust="none"),
                           pairs(train.exercise,reverse=T,adjust="none"),
                           pairs(train.socialization,adjust="none"),
                           pairs(train.sterilization,adjust="none"),
                           pairs(train.alone,adjust="none"),
                           pairs(train.experience,adjust="none"),
                           pairs(train.breed,adjust="none"))
write.list(pairwise.contrasts,file="pairwise.csv")

### age

training.age <- Effect(focal.predictors = c("Personality_age"), mod = training.model.final,
                         xlevels=list(Personality_age=c(0.2,1,2,3,4,5,6,7,8,9,10,11,12,13,14,1
5,16,17,17.1)),
                         confint=TRUE)
mean.cl <- data.frame(training.age$x,training.age$fit,training.age$lower,training.age$upper)
mean.cl

summary(pers.envi.small)




#### ***** energy ####

energy.model.final <- glm(activity_playfulness_score ~ sex + Personality_age +
                            breed_group + hobby_frequency + dogs_acquired,
                    data=pers.envi.small.ed, family=gaussian(link="identity"))

### anova with f test values
Anova(energy.model.final, type="III", test.statistic="F")

# glance of results
plot(allEffects(energy.model.final))


energy.sex <- emmeans(energy.model.final, "sex", type="response")
energy.breed <- emmeans(energy.model.final, "breed_group", type="response")
energy.hobby <- emmeans(energy.model.final, "hobby_frequency", type="response")
energy.dogs.acquired <- emmeans(energy.model.final, "dogs_acquired", type="response")



# pairwise differences
pairwise.contrasts <- list(pairs(energy.sex,adjust="none"),
                           pairs(energy.hobby,adjust="none"),
                           pairs(energy.dogs.acquired,adjust="none"),
                           pairs(energy.breed,adjust="none"))
write.list(pairwise.contrasts,file="pairwise.csv")

### age

energy.age <- Effect(focal.predictors = c("Personality_age"), mod = energy.model.final,
                       xlevels=list(Personality_age=c(0.2,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,
```

```
16,17,17.1)),
                          confint=TRUE)
mean.cl <- data.frame(energy.age$x,energy.age$fit,energy.age$lower,energy.age$upper)
mean.cl

summary(pers.envi.small)





#### ***** dominance ####

dominance.model.final <- glm(aggressiveness_dominance_score_add ~ sex +
                               Personality_age + I(Personality_age^2) +
                               breed_group + socialization_quantile,
                          data=pers.envi.small.ed, family=Gamma(link="log"))

### anova with f test values
Anova(dominance.model.final, type="III", test.statistic="F")

# glance of results
plot(allEffects(dominance.model.final))


# emmeans objects
domin.sex <- emmeans(dominance.model.final, "sex", type="response")
domin.breed <- emmeans(dominance.model.final, "breed_group", type="response")
domin.socialization <- emmeans(dominance.model.final, "socialization_quantile", type="response
")

# if effect sizes required
eff_size(domin.sex, sigma = sigma(dominance.model.final), edf = df.residual(dominance.model.fi
nal))
eff_size(domin.breed, sigma = sigma(dominance.model.final), edf = df.residual(dominance.model.
final))


# pairwise differences
pairwise.contrasts <- list(pairs(domin.sex,adjust="none"),
                           pairs(domin.socialization,adjust="none"),
                           pairs(domin.breed,adjust="none"))
write.list(pairwise.contrasts,file="pairwise.csv")

### age

dominance.age <- Effect(focal.predictors = c("Personality_age"), mod = dominance.model.final,
                         xlevels=list(Personality_age=c(0.2,1,2,3,4,5,6,7,8,9,10,11,12,13,14,1
5,16,17,17.1)),
                         confint=TRUE)
mean.cl <- data.frame(dominance.age$fit,dominance.age$lower,dominance.age$upper)
mean.cl.exp <- exp(mean.cl)
mean.cl.trans <- mean.cl.exp - 1.58

mean.cl.fin <- data.frame(dominance.age$x,mean.cl.exp,mean.cl.trans)
mean.cl.fin


summary(pers.envi.small)
```

```
#### ***** human sociability ####

human.soc.model.final <- glm(human_sociability_score ~ sex +
                               Personality_age + breed_group +
                               ownership_reason + socialization_quantile,
                       data=pers.envi.small.ed, family=gaussian(link="identity"))

### anova with f test values
Anova(human.soc.model.final, type="III", test.statistic="F")

# glance of results
plot(allEffects(human.soc.model.final))


hum.soc.sex <- emmeans(human.soc.model.final, "sex", type="response")
hum.soc.breed <- emmeans(human.soc.model.final, "breed_group", type="response")
hum.soc.reason <- emmeans(human.soc.model.final, "ownership_reason", type="response")
hum.soc.socialization <- emmeans(human.soc.model.final, "socialization_quantile", type="respon
se")


# pairwise differences
pairwise.contrasts <- list(pairs(hum.soc.sex,adjust="none"),
                           pairs(hum.soc.reason,adjust="none"),
                           pairs(hum.soc.socialization,adjust="none"),
                           pairs(hum.soc.breed,adjust="none"))
write.list(pairwise.contrasts,file="pairwise.csv")

### age

hum.soc.age <- Effect(focal.predictors = c("Personality_age"), mod = human.soc.model.final,
                     xlevels=list(Personality_age=c(0.2,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16
,17,17.1)),
                     confint=TRUE)
mean.cl <- data.frame(hum.soc.age$x,hum.soc.age$fit,hum.soc.age$lower,hum.soc.age$upper)
mean.cl

summary(pers.envi.small)




#### ***** dog sociability ####

dog.soc.model.final <- glm(dog_sociability_score ~ sex +
                             Personality_age + I(Personality_age^2) +
                             breed_group + socialization_quantile,
                     data=pers.envi.small.ed, family=gaussian(link="identity"))

### anova with f test values
Anova(dog.soc.model.final, type="III", test.statistic="F")

# glance of results
plot(allEffects(dog.soc.model.final))

dog.soc.sex <- emmeans(dog.soc.model.final, "sex", type="response")
```

```
dog.soc.breed <- emmeans(dog.soc.model.final, "breed_group", type="response")
dog.soc.socialization <- emmeans(dog.soc.model.final, "socialization_quantile", type="response
")


# pairwise differences
pairwise.contrasts <- list(pairs(dog.soc.sex,adjust="none"),
                           pairs(dog.soc.socialization,adjust="none"),
                           pairs(dog.soc.breed,adjust="none"))
write.list(pairwise.contrasts,file="pairwise.csv")

### age

dog.soc.age <- Effect(focal.predictors = c("Personality_age"), mod = dog.soc.model.final,
                      xlevels=list(Personality_age=c(0.2,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,1
6,17,17.1)),
                      confint=TRUE)
mean.cl <- data.frame(dog.soc.age$x,dog.soc.age$fit,dog.soc.age$lower,dog.soc.age$upper)
mean.cl

summary(pers.envi.small)




#### ***** perseverance ####

perseverance.model.final <- glm(perseverance_score ~ sex + Personality_age +
                                  I(Personality_age^2) +
                                  breed_group + ownership_reason + dogs_acquired,
                                data=pers.envi.small.ed, family=gaussian(link="identity"))

### anova with f test values
Anova(perseverance.model.final, type="III", test.statistic="F")

# glance of results
plot(allEffects(perseverance.model.final))


perseverance.sex <- emmeans(perseverance.model.final, "sex", type="response")
perseverance.breed <- emmeans(perseverance.model.final, "breed_group", type="response")
perseverance.reason <- emmeans(perseverance.model.final, "ownership_reason", type="response")
perseverance.dogs.acquired <- emmeans(perseverance.model.final, "dogs_acquired", type="respons
e")


# pairwise differences
pairwise.contrasts <- list(pairs(perseverance.sex,adjust="none"),
                           pairs(perseverance.reason,adjust="none"),
                           pairs(perseverance.dogs.acquired,adjust="none"),
                           pairs(perseverance.breed,adjust="none"))
write.list(pairwise.contrasts,file="pairwise.csv")

### age

perseverance.age <- Effect(focal.predictors = c("Personality_age"), mod = perseverance.model.f
inal,
                      xlevels=list(Personality_age=c(0.2,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,1
6,17,17.1)),
```

```
                      confint=TRUE)
mean.cl <- data.frame(perseverance.age$x,perseverance.age$fit,perseverance.age$lower,persevera
nce.age$upper)
mean.cl

summary(pers.envi.small.ed)
table(pers.envi.small.ed$breed_group)



#### FDR CORRECTION ####

# read in data with p-values
pvalues
head(pvalues)
summary(pvalues)
nrow(pvalues)

# make a vector of all p-values
pvalues.vector <- c(pvalues$Insecurity_p,pvalues$Training_focus_p,
                    pvalues$Energy_p,pvalues$Dominance_p,
                    pvalues$Humsoc_p,pvalues$Dogsoc_p,
                    pvalues$Perseverance_p)
length(pvalues.vector)

# correct all p-values for FDR
pvalues.adj <- p.adjust(pvalues.vector, method = "fdr")

length(pvalues$Insecurity_p)
length(pvalues$Training_focus_p)

# all columns had 1380 rows
# so let's split this vector to vectors of the same length
insecurity.padj <- pvalues.adj[1:1380]
training.padj <- pvalues.adj[1381:2760]
energy.padj <- pvalues.adj[2761:4140]
dominance.padj <- pvalues.adj[4141:5520]
humsoc.padj <- pvalues.adj[5521:6900]
dogsoc.padj <- pvalues.adj[6901:8280]
perseverance.padj <- pvalues.adj[8281:9660]

pvalues.adjusted <- data.frame(pvalues,insecurity.padj,training.padj,
                               energy.padj,dominance.padj,humsoc.padj,
                               dogsoc.padj,perseverance.padj)
summary(pvalues.adjusted)
head(pvalues.adjusted)
write.table(pvalues.adjusted,file="pvalues-adjusted.csv")


#### BREED COMPARISON ####

library(ggplot2)

#### ** insecurity ####
# highest breed: shetland sheepdog
# lowest breed: bull-type terriers
insecurity.breeds <- subset(pers.envi.small, breed_group=="Shetland_Sheepdog"|breed_group=="Bu
ll_type_terriers")
insecurity.breeds$breed_group <- droplevels(insecurity.breeds$breed_group)
```

```
ggplot(insecurity.breeds, aes(x=insecurity_score, fill=breed_group)) +
  geom_density(alpha=0.4)+ theme_minimal() +
  scale_x_continuous(limits=c(-2,4)) +
  scale_fill_manual(values=c("deepskyblue4","darkgoldenrod"),
                    labels=c("Bull type terriers","Shetland Sheepdog")) +
  guides(fill = guide_legend(title = "Breed/breed group")) +
  xlab("Insecurity score") + ylab("Density") +
  theme(legend.position = c(0.80,0.85),
        text=element_text(size=20),
        legend.text=element_text(size=14),
        legend.title=element_text(size=17),
        aspect.ratio=0.7)



#### ** training focus ####

# highest breed: other breed
# lowest breed: bull-type terriers

training.breeds <- subset(pers.envi.small, breed_group=="Other_breed"|breed_group=="Bull_type_
terriers")
training.breeds$breed_group <- droplevels(training.breeds$breed_group)
density(training.breeds$training_focus_score)

ggplot(training.breeds, aes(x=training_focus_score, fill=breed_group)) +
  geom_density(alpha=0.4)+ theme_minimal() +
  scale_x_continuous(limits=c(-6,2.5)) +
  scale_fill_manual(values=c("deepskyblue4","darkgoldenrod"),
                    labels=c("Bull type terriers","Other breed")) +
  guides(fill = guide_legend(title = "Breed/breed group")) +
  xlab("Training focus score") + ylab("Density") +
  theme(legend.position = c(0.25,0.85),
        text=element_text(size=20),
        legend.text=element_text(size=14),
        legend.title=element_text(size=17),
        aspect.ratio=0.7)



#### ** aggressiveness/dominance ####

# highest breed: fighting dogs
# lowest breed: golden retriever

domi.breeds <- subset(pers.envi.small, breed_group=="Fighting_dogs"|breed_group=="Golden_Retri
ever")
domi.breeds$breed_group <- droplevels(domi.breeds$breed_group)

ggplot(domi.breeds, aes(x=aggressiveness_dominance_score, fill=breed_group)) +
  geom_density(alpha=0.4)+ theme_minimal() +
  scale_x_continuous(limits=c(-2.5,4.5)) +
  scale_fill_manual(values=c("deepskyblue4","darkgoldenrod"),
                    labels=c("Fighting dogs","Golden retriever")) +
  guides(fill = guide_legend(title = "Breed/breed group")) +
  xlab("Aggressiveness/dominance score") + ylab("Density") +
  theme(legend.position = c(0.85,0.85),
        text=element_text(size=20),
        legend.text=element_text(size=14),
```

```
        legend.title=element_text(size=17),
        aspect.ratio=0.7)



#### ** energy ####

# highest breed: parson type terriers
# lowest breed: livestock guardian dogs

ggplot(energy.breeds, aes(x=activity_playfulness_score, fill=breed_group)) +
  geom_density(alpha=0.4)+ theme_minimal() +
  scale_x_continuous(limits=c(-4.8,3.1)) +
  scale_fill_manual(values=c("deepskyblue4","darkgoldenrod"),
                    labels=c("Livestock guardian dogs","Parson type terriers")) +
  guides(fill = guide_legend(title = "Breed/breed group")) +
  xlab("Energy score") + ylab("Density") +
  theme(legend.position = c(0.25,0.85),
        text=element_text(size=20),
        legend.text=element_text(size=14),
        legend.title=element_text(size=17),
        aspect.ratio=0.7)



#### ** human sociability ####

# highest breed: bull type terriers
# lowest breed: livestock guardian dogs

humsoc.breeds <- subset(pers.envi.small, breed_group=="Bull_type_terriers"|breed_group=="Lives
tock_guardian_dogs")
humsoc.breeds$breed_group <- droplevels(humsoc.breeds$breed_group)

ggplot(humsoc.breeds, aes(x=human_sociability_score, fill=breed_group)) +
  geom_density(alpha=0.4)+ theme_classic() +
  scale_x_continuous(limits=c(-5.9,2.6)) +
  scale_fill_manual(values=c("deepskyblue4","darkgoldenrod"),
                    labels=c("Bull type terriers","Livestock guardian dogs")) +
  guides(fill = guide_legend(title = "Breed/breed group")) +
  xlab("Human sociability score") + ylab("Density") +
  theme(legend.position = c(0.25,0.85),
        text=element_text(size=20),
        legend.text=element_text(size=14),
        legend.title=element_text(size=17),
        aspect.ratio=0.7) +
  geom_vline(data = dummy, aes(xintercept = mean))



#### ** dog sociability ####

# highest breed: finnish lapponian dog
# lowest breed: border collie

dogsoc.breeds <- subset(pers.envi.small, breed_group=="Finnish_Lapphund"|breed_group=="Border_
Collie")
dogsoc.breeds$breed_group <- droplevels(dogsoc.breeds$breed_group)
```

```
ggplot(dogsoc.breeds, aes(x=dog_sociability_score, fill=breed_group)) +
  geom_density(alpha=0.4)+ theme_minimal() +
  scale_x_continuous(limits=c(-3.6,2.7)) +
  scale_fill_manual(values=c("deepskyblue4","darkgoldenrod"),
                    labels=c("Border Collie","Finnish Lapponian Dog")) +
  guides(fill = guide_legend(title = "Breed/breed group")) +
  xlab("Dog sociability score") + ylab("Density") +
  theme(legend.position = c(0.25,0.85),
        text=element_text(size=20),
        legend.text=element_text(size=14),
        legend.title=element_text(size=17),
        aspect.ratio=0.7)


#### ** perseverance ####

# highest breed: miniature pinscher
# lowest breed: golden retriever

perseverance.breeds <- subset(pers.envi.small, breed_group=="Miniature_Pinscher"|breed_group==
"Golden_Retriever")
perseverance.breeds$breed_group <- droplevels(perseverance.breeds$breed_group)

ggplot(perseverance.breeds, aes(x=perseverance_score, fill=breed_group)) +
  geom_density(alpha=0.4)+ theme_minimal() +
  scale_x_continuous(limits=c(-4.8,4.1)) +
  scale_fill_manual(values=c("deepskyblue4","darkgoldenrod"),
                    labels=c("Golden Retriever","Miniature Pinscher")) +
  guides(fill = guide_legend(title = "Breed/breed group")) +
  xlab("Perseverance score") + ylab("Density") +
  theme(legend.position = c(0.25,0.85),
        text=element_text(size=20),
        legend.text=element_text(size=14),
        legend.title=element_text(size=17),
        aspect.ratio=0.7)



#### VARIABLE IMPORTANCE ####

# for calculating relative variable importance
library(vip)

# for calculating cohen's f2 effect sizes
library(effectsize)

# writing out lists
library(erer)

# needed for scores
library(pdp)



#### *** insecurity ####

insecurity.model.final <- glm(insecurity_score_add ~ sex + Personality_age +
                                I(Personality_age^2) +
                                breed_group + socialization_quantile +
```

```
                                sterilization_status + dog_experience +
                                ownership_reason + hobby_frequency,
                              data=pers.envi.small, family=Gamma(link="log"))

insecurity.anova <- Anova(insecurity.model.final, type="III", test.statistic="F")

insecurity.scores <- vi(insecurity.model.final, method = "firm",scale=T)
insecurity.cohen <- cohens_f_squared(insecurity.anova, partial = T)


#### *** training focus ####

training.model.final <- glm(training_focus_score ~ sex + Personality_age +
                              I(Personality_age^2) +
                              breed_group + hobby_frequency + daily_exercise +
                              socialization_quantile + sterilization_status +
                              alone_time + dog_experience,
                            data=pers.envi.small, family=gaussian(link="identity"))
training.anova <- Anova(training.model.final, type="III", test.statistic="F")

training.scores <- vi(training.model.final, method = "firm",scale=T)
training.cohen <- cohens_f_squared(training.anova, partial = T)



#### *** aggressiveness/dominance ####

dominance.model.final <- glm(aggressiveness_dominance_score_add ~ sex +
                               Personality_age + I(Personality_age^2) +
                               breed_group + socialization_quantile,
                             data=pers.envi.small, family=Gamma(link="log"))
dominance.anova <- Anova(dominance.model.final, type="III", test.statistic="F")

dominance.scores <- vi(dominance.model.final, method = "firm",scale=T)
dominance.cohen <- cohens_f_squared(dominance.anova, partial = T)



#### *** energy ####

energy.model.final <- glm(activity_playfulness_score ~ sex + Personality_age +
                            breed_group + hobby_frequency + dogs_acquired,
                          data=pers.envi.small, family=gaussian(link="identity"))
energy.anova <- Anova(energy.model.final, type="III", test.statistic="F")

energy.scores <- vi(energy.model.final, method = "firm",scale=T)
energy.cohen <- cohens_f_squared(energy.anova, partial = T)



#### *** human sociability ####

human.soc.model.final <- glm(human_sociability_score ~ sex +
                               Personality_age + breed_group +
                               ownership_reason + socialization_quantile,
                             data=pers.envi.small, family=gaussian(link="identity"))
hum.soc.anova <- Anova(human.soc.model.final, type="III", test.statistic="F")

hum.soc.scores <- vi(human.soc.model.final, method = "firm",scale=T)
```

```r
hum.soc.cohen <- cohens_f_squared(hum.soc.anova, partial = T)



#### *** dog sociability ####

dog.soc.model.final <- glm(dog_sociability_score ~ sex +
                             Personality_age + I(Personality_age^2) +
                             breed_group + socialization_quantile,
                           data=pers.envi.small, family=gaussian(link="identity"))
dog.soc.anova <- Anova(dog.soc.model.final, type="III", test.statistic="F")

dog.soc.scores <- vi(dog.soc.model.final, method = "firm",scale=T)
dog.soc.cohen <- cohens_f_squared(dog.soc.anova, partial = T)



#### *** perseverance ####

perseverance.model.final <- glm(perseverance_score ~ sex + Personality_age +
                                  I(Personality_age^2) +
                                  breed_group + ownership_reason + dogs_acquired,
                                data=pers.envi.small, family=gaussian(link="identity"))
perseverance.anova <- Anova(perseverance.model.final, type="III", test.statistic="F")

perseverance.scores <- vi(perseverance.model.final, method = "firm",scale=T)
perseverance.cohen <- cohens_f_squared(perseverance.anova, partial = T)


#### **** list of all ####

results <- list(insecurity.scores, insecurity.cohen,
                training.scores, training.cohen,
                dominance.scores, dominance.cohen,
                energy.scores,energy.cohen,
                hum.soc.scores, hum.soc.cohen,
                dog.soc.scores, dog.soc.cohen,
                perseverance.scores, perseverance.cohen)
names <- c("insecurity relative", "insecurity cohen's f",
           "training relative", "training cohen's f",
           "dominance relative", "dominance cohen's f",
           "energy relative", "energy cohen's f",
           "hum soc relative", "hum soc cohen's f",
           "dog soc relative", "dog soc cohen's f",
           "perseverance relative", "perseverance cohen's f")
write.list(results,file="effect-sizes.csv", t.name=names)
```