

Genetic analysis of mentality traits in Rhodesian Ridgeback dogs

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Objectives:

- By factor analysis merge the 33 behavioral variables of the Swedish dog mentality assessment (DMA) into a number of personality reflecting dimensions (factors) for the breed Rhodesian Ridgeback
- Predict breeding values for these factors for possible use in selection programmes.



Introduction:

Mentality tests for dogs are important tools for dog owners, breeders, breed clubs, military, police, guide dog organizations etc etc.

In order to be useful tools, tests should be:

- **Specific measurements** for the traits we wish to learn something about
- **Standardized** to reduce environmental noise
- **Selection criteria** useful for breeding

The dataset



- Dataset provided by the Swedish Kennel Club
- Total dataset $n=10155$
- 1209 known sires, 1618 known dams
- 138 dogs with incomplete results were excluded from the analyses (aborted by judge or owner or omitted gunshot and/or exploration)
- 2022 dogs with complete DMA results from June 1997 to Oct 2012
- The 2022 dogs were born in 604 litters
- 50.4% males, 49.6% females
- Average age at test 760 days ($SD=352$)
- 60% of tested dogs below 2 years of age
- Dogs were tested by 161 judges at 529 separate occasions
- Average number of dogs tested each year 126 ($SD=57$)

Dog Mentality Assessment

A close-up profile of a brown dog's head, likely a Swedish Working Dog, against a clear blue sky. The dog's fur is a mix of light and dark brown, and its eyes are a reddish-brown color. The dog is looking towards the left of the frame.

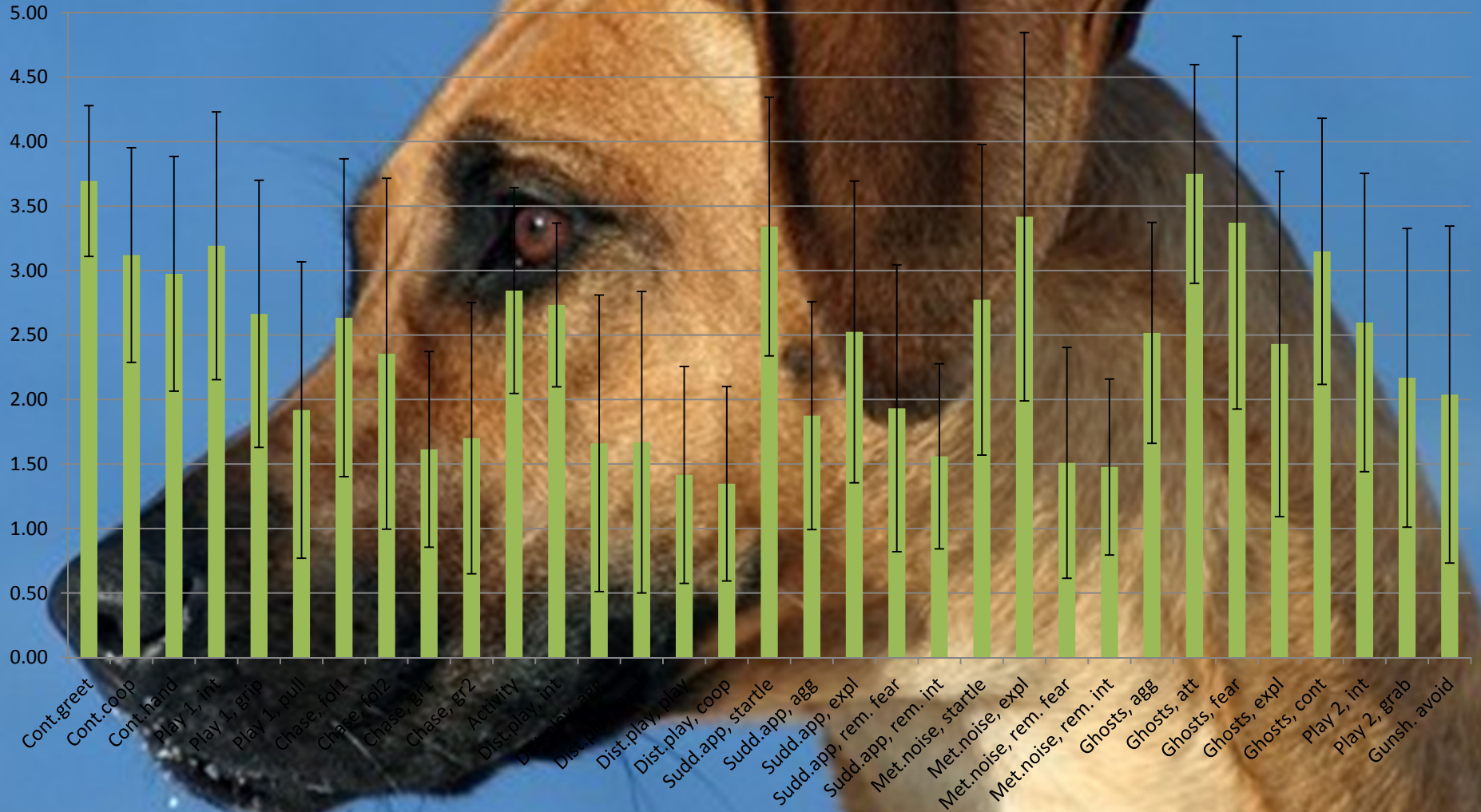
- Swedish test made for the Swedish Working Dog association in 1981, open for all breeds since 1997
- 10 subtests, 33 behavioral variables, 5 possible scores on an intensity scale with one score per variable

Subtest

Behavioral variable

- Social contact
 - Play 1
 - Chase
 - Passive situation
 - Distance-play
 - Sudden appearance
 - Metallic noise
 - Ghosts
 - Play 2
 - Gunshot
- 1a Greeting, 1b Cooperation, 1c Handling
2a Interest, 2b Grip, 2c Pull
3a1 Following1, 3b1 Grabbing1,
3a2 Following2, 3b2 Grabbing2
4 Activity
5a Interest, 5b Aggression,
5c Curiosity/exploration, 5d Willingness to play,
5e Cooperation
6a Startle, 6b Aggression, 6c Curiosity/exploration,
6d Remaining fear, 6e Remaining interest
7a Startle reaction, 7b Curiosity/exploration,
7c Remaining avoidance, 7d Remaining interest
8a Aggression, 8b Attention, 8c Fear,
8d Curiosity/exploration, 8e Contact
9a Interest, 9b Grabbing
10 Avoidance

Average



The average scores with standard errors for each behavioral variable



Method:

- Excel and SAS were used for descriptive analysis
- The preliminary analysis and the factor analysis were performed in SAS
- Variance components and heritabilities were calculated with Wombat
- Breeding values were predicted using Matlab



The model used for analyses of the 33 behavioral variables

Test score = sex + test year + test month + age class + breeding value + residual

where

- Test score is the score of the behavioral trait of a dog
- Sex = male or female
- Test year=1997-2012
- Test month=1-12
- Age class 1=12-18 months, 2=18-24 months, 3=24-30 months, 4=30-36 months, 5=36 months and older
- Breeding value is a random additive breeding value $a \sim N(0, A\sigma_a^2)$
- Residual is random $e \sim N(0, I\sigma_e^2)$.
- A is the numerator relationship matrix and I is the identity matrix of appropriate size

Fixed effects:

- Sex and age category had significant effects on approximately 60% of the variables
- Test year and month had effect on less than half of the variables
- For four variables, sudden appearance aggression, metallic noise, startle reaction, ghost attention and contact, no effects were significant
- For the distance play and the play 2 subtests, all effects were significant

Factor analysis:

- Analysed with both raw data and residual data (corrected for fixed effects)
- Raw data was analyzed with print and principal factor analysis and considered both unrotated and with varimax rotation
- Principal factor analysis with varimax rotation was also performed on the residual data

Criteria for chosen method and number of factors were

- Eigenvalues >1
- Highest number possible of variables explained through the factors
- Loadings of each variable above threshold of 0,4/-0,4
- Each variable should only have high loading on one factor

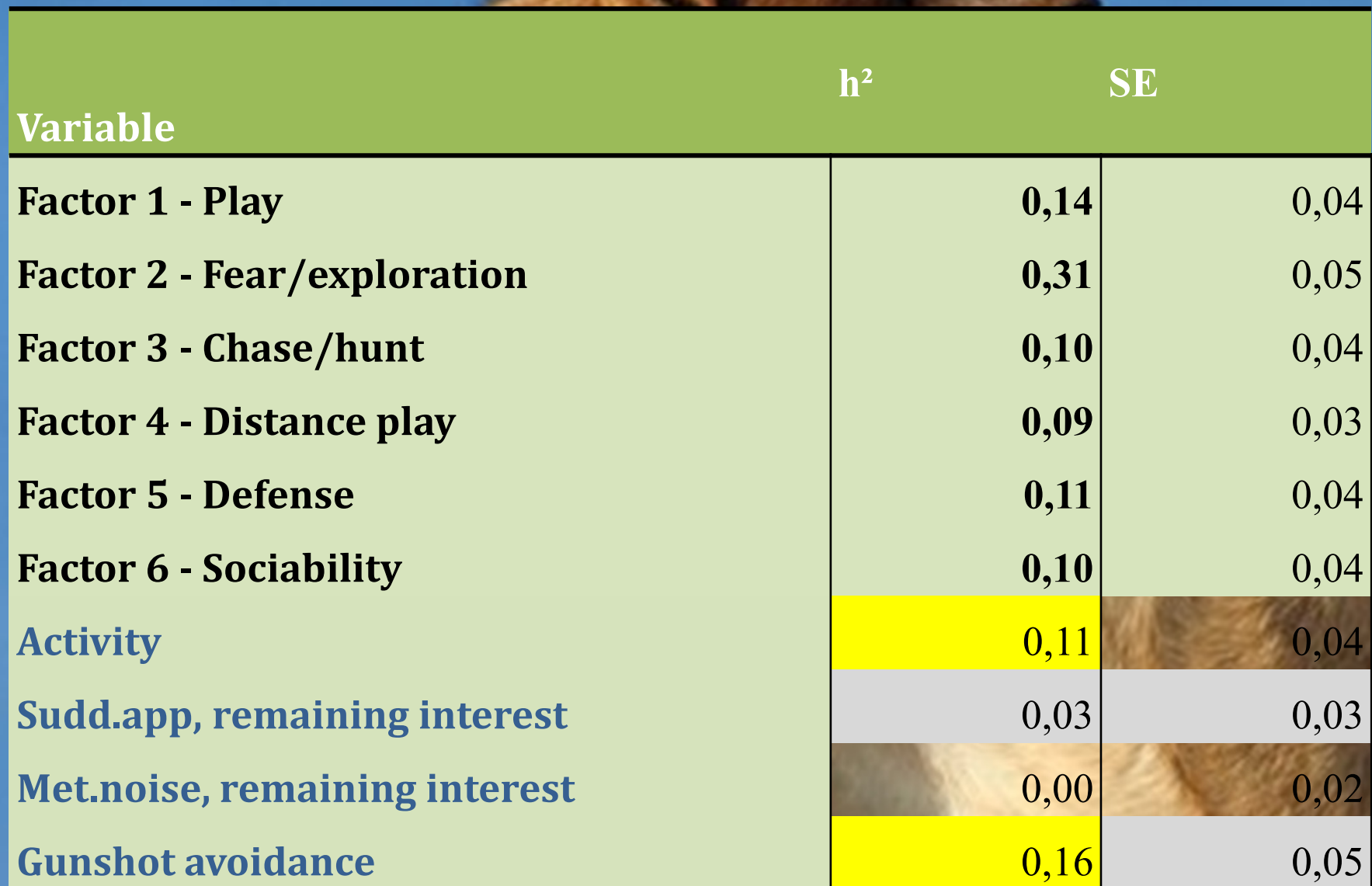
Result of principal factor analysis with varimax rotation on residual data

	Factor 1 Play	2 Fear/curiosity	3 Chase	4 Distance play	5 Defense	6 Sociability
Contact, greeting	0,16	-0,07	0,01	0,05	0,02	0,60
Contact, cooperation	0,17	-0,05	-0,02	0,12	-0,03	0,67
Contact, handling	0,08	-0,05	-0,06	0,15	-0,04	0,68
Play 1, interest	0,75	-0,04	0,09	0,10	0,07	0,26
Play 1, grip	0,79	0,01	0,14	0,02	0,02	0,15
Play 1, pull	0,66	-0,01	0,11	0,20	0,05	0,18
Chase, following1	0,11	-0,08	0,79	0,10	0,02	-0,05
Chase, grabbing1	0,15	-0,02	0,81	0,07	0,00	0,00
Chase, following2	0,09	-0,11	0,79	0,06	0,01	-0,01
Chase, grabbing2	0,16	-0,09	0,78	0,01	-0,01	0,03
Activity	0,09	0,11	0,00	-0,01	0,14	0,08
Distance play, interest	0,05	0,08	0,06	0,13	0,47	0,07
Distance play, aggression	-0,01	0,08	-0,09	-0,16	0,61	0,05
Distance play, exploration	0,04	-0,10	0,12	0,78	-0,01	0,09
Distance play, play	0,17	-0,02	0,10	0,85	0,02	0,15
Distance play, coop	0,13	-0,01	0,08	0,84	0,01	0,16
Sudden app, startle	0,01	0,58	0,03	-0,12	0,07	0,06
Sudden app, aggression	0,08	-0,06	-0,05	-0,01	0,65	-0,08
Sudden app, exploration	0,02	-0,66	0,09	0,04	0,00	-0,06
Sudden app, rem. fear	0,00	0,66	-0,09	0,02	0,01	-0,18
Sudden app, rem. interest	-0,01	-0,03	0,00	0,08	0,14	0,12
Metallic noise, startle	-0,03	0,64	-0,05	0,00	-0,07	-0,07
Metallic noise, explor	0,11	-0,60	0,18	-0,08	0,10	-0,01
Metallic noise, rem. fear	-0,03	0,59	-0,07	0,14	-0,04	-0,20
Metallic noise, rem. int	0,14	-0,04	0,01	0,00	0,12	0,02
Ghosts, aggression	0,00	-0,05	0,05	-0,08	0,76	-0,03
Ghosts, attention	-0,01	-0,13	0,06	0,05	0,58	-0,10
Ghosts, fear	-0,08	0,41	0,15	-0,21	0,09	0,34
Ghosts, exploration	0,15	-0,52	-0,07	0,31	-0,08	-0,25
Ghosts, contact	0,16	-0,42	-0,10	0,30	0,08	-0,04
Play 2, interest	0,85	-0,07	0,12	0,10	-0,01	-0,05
Play 2, grabbing	0,81	-0,06	0,13	0,03	0,00	-0,06
Gunshot, avoidance	0,11	0,34	-0,05	-0,02	-0,01	-0,20

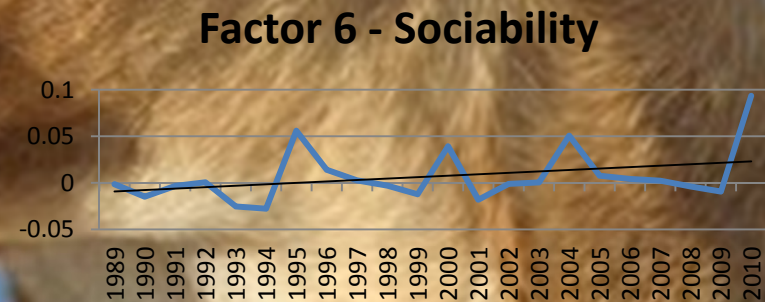
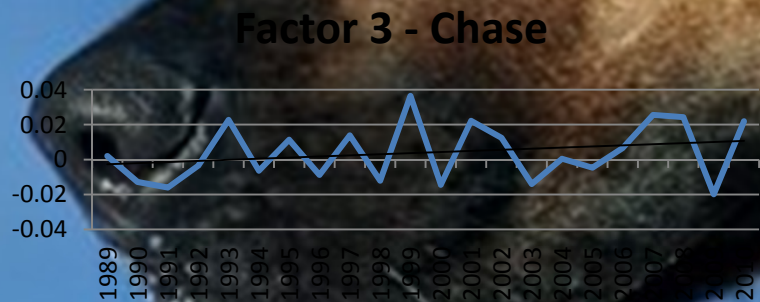
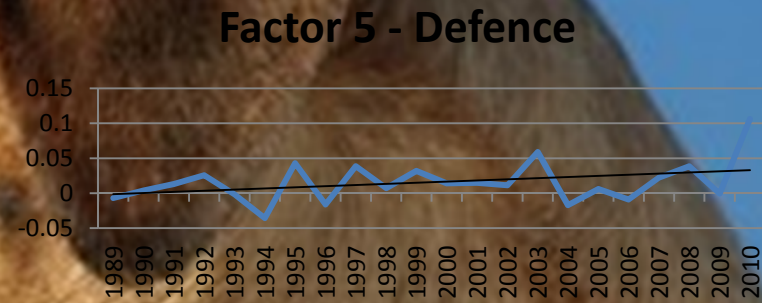
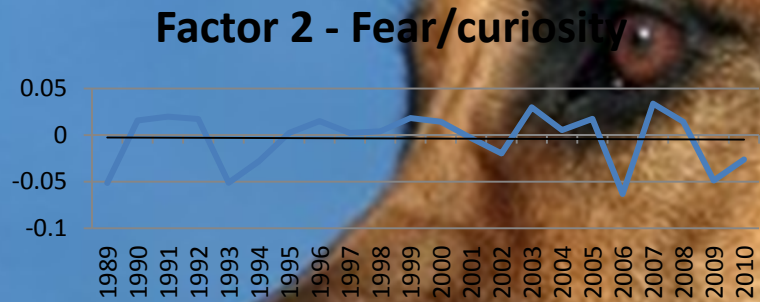
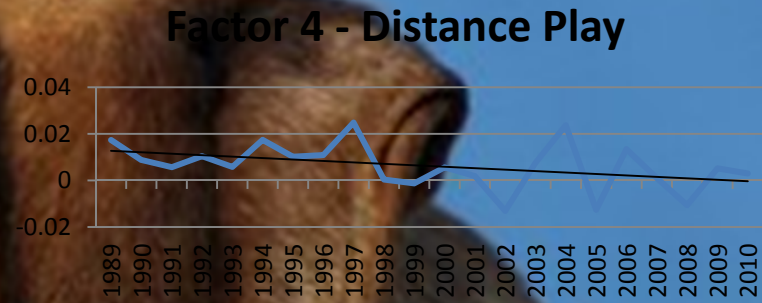
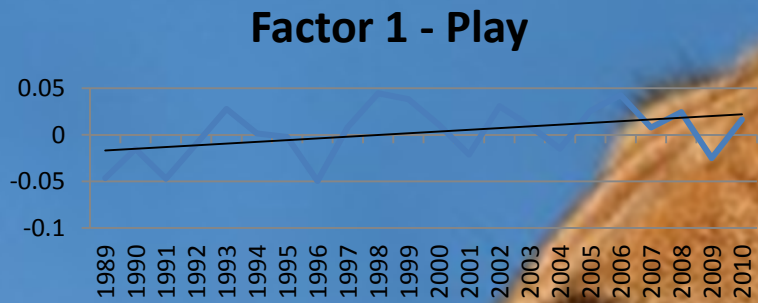
A close-up profile of a brown dog's head, likely a pit bull mix, looking towards the left. The dog has a black nose and dark eyes. The background is a clear, bright blue sky. The text is overlaid on the image.

Heritabilities:

Heritabilities for all of the six factors were higher than for the separate behavioral variables of the group, or higher than the average of the group (factors distance play, defense and sociability). There were no significant heritabilities for the two unexplained behavioral variables of remaining interest for the sudden appearance and the metallic noise. For the unexplained behavioral variables activity and gunshot avoidance, heritabilities are moderate.



Variable	h^2	SE
Factor 1 - Play	0,14	0,04
Factor 2 - Fear/exploration	0,31	0,05
Factor 3 - Chase/hunt	0,10	0,04
Factor 4 - Distance play	0,09	0,03
Factor 5 - Defense	0,11	0,04
Factor 6 - Sociability	0,10	0,04
Activity	0,11	0,04
Sudd.app, remaining interest	0,03	0,03
Met.noise, remaining interest	0,00	0,02
Gunshot avoidance	0,16	0,05



Average BV over the years (genetic trend) for the 6 factors

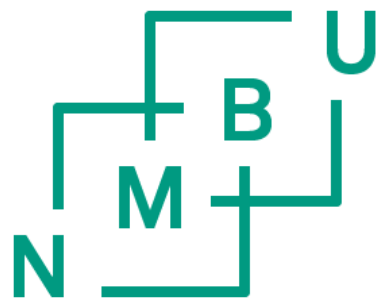
Breeding Values



- Factors 2 and 4 have negative trends (factor 2 shows almost no trend), while factors 1, 3, 5 and 6 show positive trends.
- In the case of the second factor, fear/exploration, a negative trend is good, as this factor is composed of the behavioral variables fear and exploration/curiosity, and thus a positive trend would mean more fearful animals. Between the years 1995-2005, average breeding value for factor 2 has mainly been positive, which in this case means breeding fearful dogs.
- The average breeding value for factor four, the distance play, is negative, with average breeding values before 1998 all positive, and from 1999-2010 they fluctuate between -0,02 and 0,02.
- For the defense factor, average breeding values has ranged from -0,04 to 0,06 up to 2009, but in 2010 spiked at over 0,1.
- In factor six, sociability, there is a positive trend which goes from -0,03 to almost 0,1. Averages are primarily on the negative side before 1994. As can be seen, there is a steady decline from 2004 to 2009, but then a sharp rise from 2009 to 2010.
- Average breeding value for the third factor, chase/hunt ranges from -0,02 to almost 0,03, with a slight positive trend.

Conclusion:

- Dog Mentality Assessment is suited for use with breeding values
- Factor analysis should be done for each breed separately if BV's are to be predicted
- For Rhodesian Ridgebacks, just a few (4/33) behavioral variables did not provide information to the 6 factors.
- Gunshot avoidance does not fit in any factor in this material but is important for the welfare of dogs and has a high heritability. This trait should therefore be included in future breeding value estimation
- The rest of the behavioral variables group into personality reflecting dimensions/factors, but have also separate functions (fear of noise is not equal to fear of objects) and should not be removed from the test
- Further analyses is needed to determine what is desired scores for this breed on the behavioral variables and how behavior of the breed in question reflect in the test



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