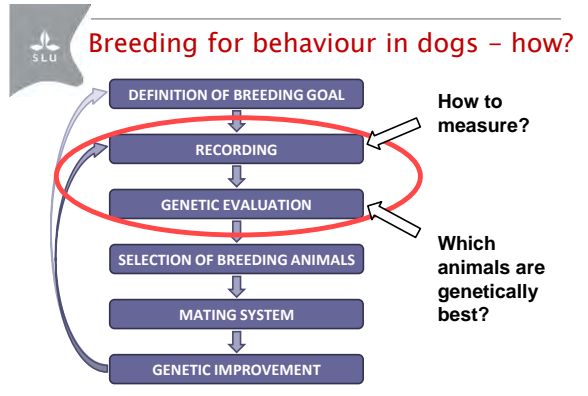


Genetic Evaluation of Behaviour in Dogs

Per Arvelius
Canine Behaviour and
Genetics Meeting
London
26–28 June 2015

Photo: Malin Wik



Which animals are genetically best?

- Behavioural traits are quantitative - affected by many genes and environment together
- Tricky to select breeding animals



Genetic evaluation

Estimated breeding value (EBV)

- Phenotype adjusted for environmental factors
- Information from relatives taken into account

EBVs are effective – the most objective way to rank breeding animals

EBVs (almost) not used at all in dog breeding



Genetic evaluation and selection based on EBVs increases the genetic improvement

Example: English Setter hunting traits



Setter Field Trials



Photo: Maud Matsson

- Hunting ability tested in field trials
- Similar trials in Sweden and Norway
- Potential increase in genetic improvement by using EBVs and by merging the populations



Substantially increased genetic improvement in Sweden is possible

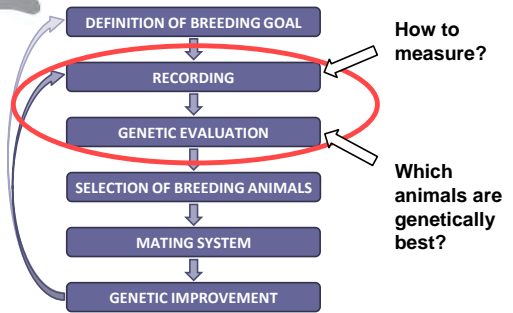
Mean accuracy for different selection methods		Potential increase in genetic improvement
Phenotype alone:	0.33	
EBVs, national data:	0.55	
EBVs, joint data:	0.65	

66%
18%
95%

Arvelius & Klemetsdal (2013) J. Anim. Breed. Genet. 130: 142–153



Breeding for behaviour in dogs – how?



Effect of score sheet structure on genetic improvement



Photo: ©United States Border Collie Club



Herding Trait Characterization (HTC)

Swedish Sheepdog Society

Purpose: Selection of breeding animals

Two versions of the HTC

"Old version" (1989-1995): 17 traits

"New version" (1996-2003): 19 traits



Differences between score sheets

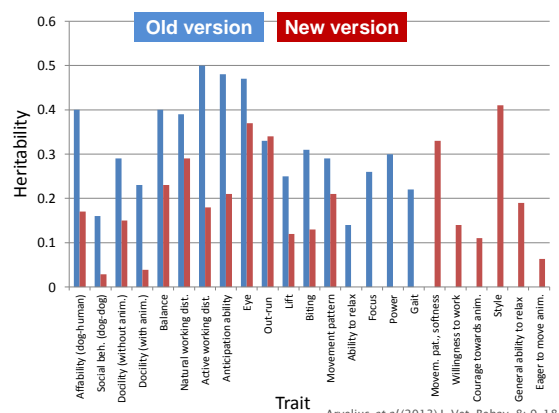
Trait *Active working distance*

Old version

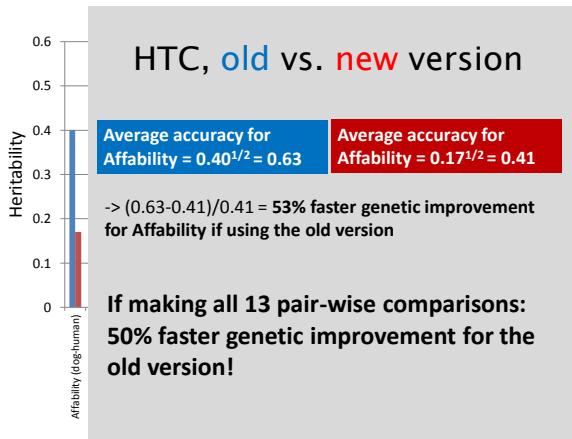
- 0-1 m
- 1-2 m
- 2-3 m
- 3-5 m
- 5-10 m
- >10 m

New version

- Animals do not move
- Dog needs to move **very** close
- Dog needs to go **rather** close
- Dog needs **medium long** distance
- Dog needs **long** distance
- Dog needs **very long** distance



Arvelius et al (2013) J. Vet. Behav. 8: 9–18



- ### Most likely reasons for lower heritabilities in the new version
- Old version based on increasing intensity
 - Less objective measures, values (good, bad, too far away, ...) used in the **new** version
 - New trait "**Courage**":
 1. acts cowardly
 2. somewhat afraid of the animals
 3. too cautious
 4. normally cautious
 5. very unafraid
 6. death wish (lacks self preservation)

Are objective measures always better than subjective?



- ### Swedish Armed Forces dog temperament test
- "All" dogs in the Swedish Armed Forces breeding program given a temperament test when 15-17 months old
 - 12 sub-tests
 - Two rating methods used simultaneously: behavioural ratings (BR) and subjective ratings (SR)

Example

Behavioural ratings

Sub-test	Rating	1	2	3	4	5
Visual startle	Flight distance	Escapes >5 m	Escapes 2-5 m	Escapes 1-2 m	Jerks without escaping	No fear response
Visual startle	Aggression	No sign of aggr.	Some signs of aggr.	Several signs of aggr.	Several signs of aggr. and attack	Aggr., attacks, bites

Subjective ratings

Trait	Definition	1	2	3	4	5
Courage	"The absence of fearful behaviour toward real or imagined danger..." ¹	Insignificant	Weak	Some	Strong	Very strong

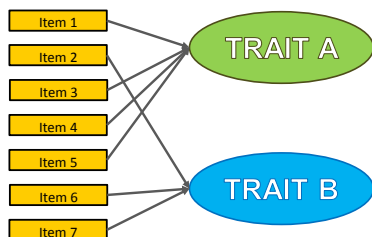
¹ Wilsson and Sinn (2012) Appl. Anim. Beh. Sci. 141: 158-172

How much does rating method affect the heritability?

Trait	Heritability	
	BR	SR
(Physical) Engagement	0.22	0.28
Confidence	0.23	0.19
Aggression	0.18	0.12

Arvelius *et al.* (2014) J. Vet. Behav. 9: 281-289.

Summarizing measured items into composite traits



DMA ITEMS	FACTORS				
	Playfulness	Curiosity/ Fearlessness	Chase- proneness	Sociability	Aggressive- ness
SOCIAL CONTACT - Greeting	0.15	0.04	0.01	0.65	0.07
SOCIAL CONTACT - Cooperation	0.15	0.05	0.04	0.64	0.03
SOCIAL CONTACT - Handling	0.14	0.08	0.01	0.61	0.01
PLAY 1 - Interest in play	0.76	0.04	0.12	0.21	0.11
PLAY 1 - Grabbing	0.77	0.01	0.12	0.08	0.08
PLAY 1 - Tug of war	0.67	0.04	0.16	0.18	0.10
CHASE - Following 1	0.14	0.17	0.79	0.03	0.12
CHASE - Following 2	0.17	0.10	0.75	-0.01	0.09
CHASE - Grabbing 1	0.12	0.16	0.68	0.04	0.02
CHASE - Grabbing 2	0.17	0.09	0.64	0.02	0.05
PASSIVE SITUATION - Activity	0.14	-0.01	0.08	0.10	0.06
DISTANCE PLAY - Interest	0.19	0.11	0.20	0.12	0.21
DISTANCE PLAY - Aggression	0.01	-0.08	0.00	-0.01	0.51
DISTANCE PLAY - Exploration	0.36	0.24	0.39	0.31	-0.01
DISTANCE PLAY - Tug-of-war	0.53	0.18	0.37	0.33	0.00
DISTANCE PLAY - Play invitation	0.48	0.19	0.37	0.33	0.01
SUDDEN APPEARANCE - Startle reaction	0.00	-0.60	-0.08	0.01	-0.01
SUDDEN APPEARANCE - Aggression	0.10	0.09	0.09	0.00	0.57
SUDDEN APPEARANCE - Exploration	0.05	0.57	0.10	0.00	0.02
SUDDEN APPEAR - Remaining avoidance	-0.07	-0.58	-0.01	-0.08	0.00
SUDDEN APPEAR - Remaining approach	0.05	-0.09	0.12	0.10	0.18
METALLIC NOISE - Startle reaction	-0.05	-0.64	-0.09	0.05	-0.12
METALLIC NOISE - Exploration	0.11	0.60	0.11	-0.03	0.15
METALLIC NOISE - Remaining avoidance	-0.07	-0.60	-0.01	-0.02	-0.06
METALLIC NOISE - Remaining approach	0.01	-0.13	0.09	0.10	0.11
GHOSTS - Aggression	0.06	0.10	-0.01	-0.03	0.76
GHOSTS - Attention	0.11	0.20	0.07	0.07	0.44
GHOSTS - Avoidance	-0.03	-0.35	-0.08	-0.09	0.06
GHOSTS - Exploration	0.08	0.48	0.07	0.19	-0.12
GHOSTS - Greeting	0.13	0.36	0.07	0.37	0.00
PLAY 2 - Interest in play	0.83	0.18	0.10	0.08	0.10

Temperament test or questionnaire?



Dog Mentality Assessment (DMA)

- Standardized test battery containing 10 test situations
- 33 behaviour reactions are scored 1-5 by certified judge



DMA heritabilities (Collie)

Individual items: 0.03-0.30, average 0.14 (SE 0.02-0.04)

Composite traits generally higher:

Trait	Heritability
Playfulness	0.25
Curiosity/Fearlessness	0.20
Chase-proneness	0.16
Sociability	0.22
Aggressiveness	0.14

(SE 0.03-0.04)

Arvelius et al. (2014) J. Anim. Sci. 92: 4843-4855



Canine Behavioral Assessment and Research Questionnaire (C-BARQ)

Hsu & Serpell (2003) J. Am. Vet. Med. Assoc. 223: 1293-1300

101 questions on frequency or intensity of a dog's typical behaviour. Can be condensed into 15 composite traits.

Thinking back over the recent past, please indicate how often your dog has chased or would chase squirrels, rabbits and other small animals given the opportunity:

0 Never 1 Seldom 2 Sometimes 3 Often 4 Always

Please indicate your own dog's recent tendency to display fearful behavior in response to sudden or loud noises (e.g. vacuum cleaner, car backfire, road drills, objects being dropped, etc.):

No fear/anxiety: No visible signs of fear 0 Mild—Moderate fear/anxiety 1 2 3 4 Extreme fear: cowers; retreats or hides, etc.



Heritabilities for C-BARQ traits (Collie)

DMA trait	h^2		Questionnaire trait	h^2
Playfulness	0.25	$r_g = 0.63$	Human-directed play interest	0.28
Curiosity/ Fearlessness	0.20	$r_g = -0.70$	Non-social fear	0.36
Chase-proneness	0.16	$r_g = 0.73$	Chasing	0.14
Sociability	0.22	$r_g = -0.80$	Stranger-directed fear	0.25
		$r_g = 0.87$	Stranger-directed interest	0.29
(SE $_{h^2}$ 0.03-0.04)		(SE $_{r_g}$ 0.08-0.12)	(SE $_{h^2}$ 0.04-0.06)	

Arvelius *et al.* (2014) J. Anim. Sci. 92: 4843-4855



Summary

1. Dog behaviour shows genetic variation and can therefore be improved by breeding
2. Modern techniques for estimating breeding values have a huge potential to increase genetic improvement of dog behaviour
3. Behavioural measurements should (usually) be objective and neutral, and summarized into composite traits