Crossbreed genetic analysis of a standardised behavioural test for potential guide dog puppies

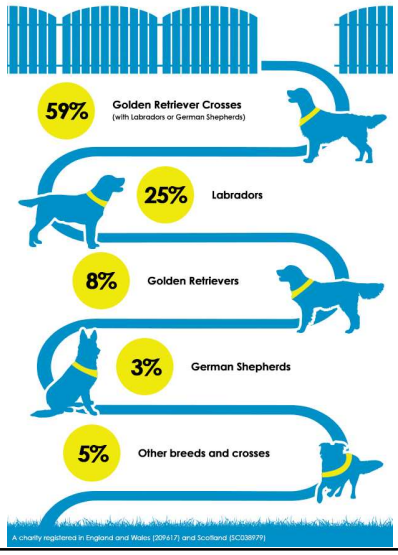
Katy M. Evans[1,4], Thomas W. Lewis[3,4], Lucy Asher[1], Simon Blythe[1,2], Matthew Bottomley[2], Lisa Tootill[2], Rena Roberts[2], Helen Whiteside[2], Gary C.W. England[1], Sarah C. Blott[1,4]

[1] School of Veterinary Medicine and Science, The University of Nottingham, UK
[2] Guide Dogs, UK
[3] The Kennel Club, UK
[4] Formerly of the Animal Health Trust, Newmarket, UK

Introduction

- Guide Dogs are the largest breeder and trainer of working dogs in the world.
- Guide Dogs are currently responsible for nearly 8,000 dogs including breeding stock and retired animals.
- More than 4,700 guide dog owners in the UK.

Guide Dogs' breeds



Breeding

- The organisation breeds the majority of its own dogs.
- Around 80 stud dogs and 275 brood bitches.
- New, purpose-built National Breeding Centre (NBC) opened in 2011 giving capacity to breed 1500 puppies a year.

National Breeding Centre

Success rate

- 70% of puppies bred by Guide Dogs successfully become working guide dogs or breeding stock.

- Hoping to increase this proportion further using quantitative genetic techniques.

Early puppy management

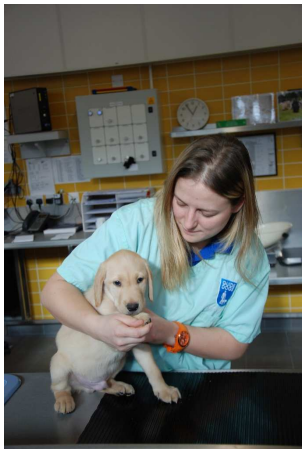
- Most brood bitches whelp in the homes of their volunteer Brood Bitch Holders.
- A small number will whelp in the National Breeding Centre.
- All puppies return to the National Breeding Centre at 6 weeks of age.
- Puppies then go to volunteer Puppy Walkers' homes at 7 weeks of age.

Entering NBC at 6 weeks

Settled in

Puppies at NBC

- Veterinary checks and vaccinations.
- Intensive socialisation programme.
- Puppy Profiling Assessment (PPA).



Puppy Profiling Assessment (PPA)

- A puppy test developed by Guide Dogs.
- Used to assess the behaviour of puppies prior to placement with Puppy Walkers.
- Developed to be feasible and standardised.
- Criterion validity has been assessed
- Came into routine use in April 2012.

Puppy Profiling Assessment (PPA)

Journal of Veterinary Behavior 8 (2013) 431–438

Contents lists available at ScienceDirect

Journal of Veterinary Behavior

journal homepage: www.journalvetbehavior.com

Research

A standardized behavior test for potential guide dog puppies: Methods and association with subsequent success in guide dog training

Lucy Asher[a,*], Simon Blythe[a,b], Rena Roberts[b], Lisa Toothill[b], Peter J. Craigon[a,b], Katy M. Evans[c], Martin J. Green[a], Gary C.W. England[a]

[a] School of Veterinary Medicine and Science, University of Nottingham, Sutton Bonington Campus, Loughborough, Leicestershire, UK
[b] Guide Dogs for the Blind Association, Burghfield Common, Reading, UK
[c] Animal Health Trust, Lanwades Park, Kentford, Newmarket, Suffolk, UK

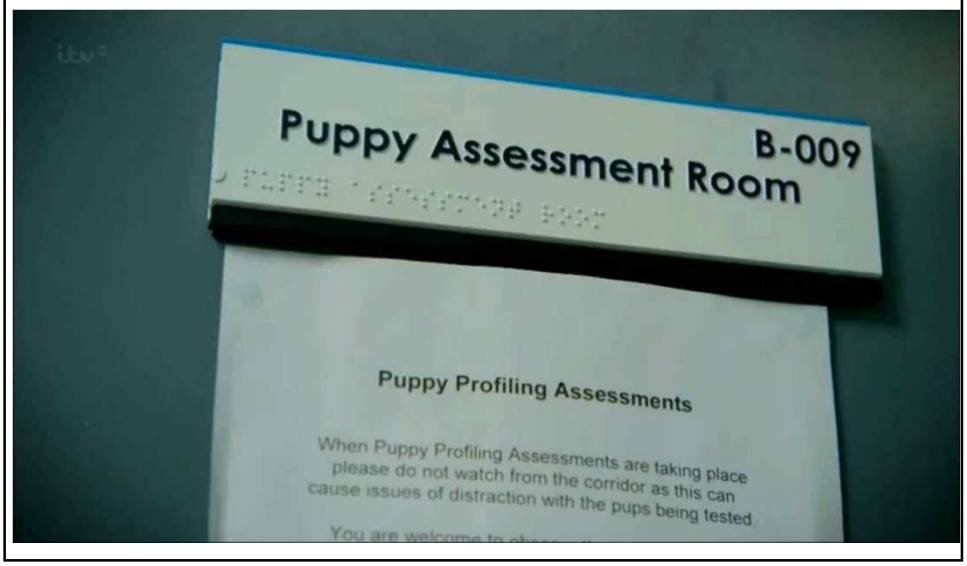
PPA description 1

- PPA consists of 11 components, each scored on a 7-point scale.
- Components measure responsiveness, willingness and confidence.

PPA description 2

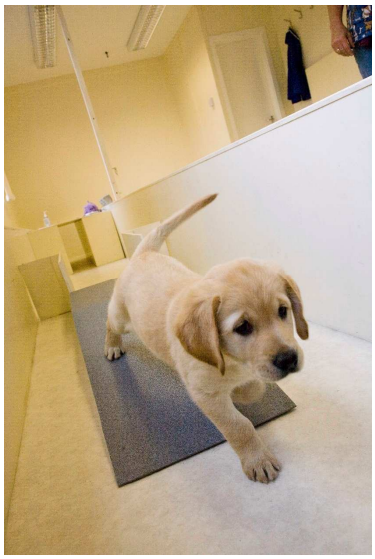
Component	Description
1	Following
2a	Retrieve – response to stimulus
2b	Retrieve – response to assessor
3	Restraint
4	Noise
5a	Stroking – response to stimulus
5b	Stroking – response to assessor
6a	Squirrel – response to stimulus
6b	Squirrel – response to assessor
7	Tunnel
8	Ramp

PPA video



Tunnel

Ramp



Description of dataset 1

- Two years of data from April 2012 to April 2014 used in analyses.
- For this analysis only Labrador Retriever (Lab), Golden Retriever (G Ret) and their crosses bred by Guide Dogs were included.

Description of dataset 2

- Resultant dataset consisted of PPA results for 2127 puppies from 298 litters.
- Average litter size was 7.1 pups.
- 62 unique sires and 229 unique dams.
- 47% of the puppies were female and 53% were male.

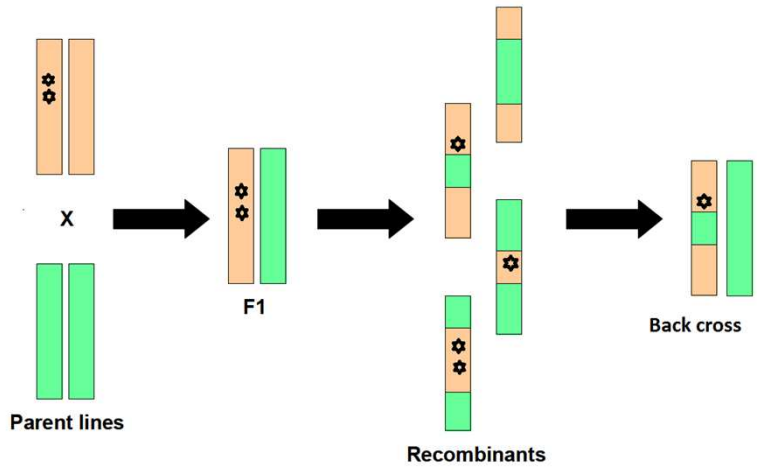
Description of dataset 3

Breed	Number of pups
Golden Retriever X Labrador	950
Labrador Retriever	704
Lab x (G Ret x Lab)	315
Golden Retriever	119
G Ret x (G Ret x Lab)	39
Total	2127

Crossbreed genetic analysis

- Simple crossbreed models used.
- Method described by Van der Werf and de Boer (1989).
- Expected heterosis and recombination loss for each individual was calculated from the proportion of Labrador Retriever and Golden Retriever of their sire and dam.

Heterosis and recombination loss



Crossbreed genetic analysis 2

- Expected heterosis value is the probability that the two alleles at any one locus originate from different breeds.
- Expected recombination loss value is the probability that any two loci inherited from the same parent originate from different breeds.

Crossbreed genetic analysis 2

Breed	Heterosis	Recombination loss	Labrador fraction
Golden Retriever	0	0	0
Labrador Retriever	0	0	1
GR x LR	0.5	0	0.5
GR x (GR x LR)	0.25	0.125	0.25
LR x (GR x LR)	0.25	0.125	0.75
(GR x LR) x (GR x LR)	0.25	0.25	0.5

Description of models

- Heritabilities and other genetic parameters estimated using univariate linear mixed models in ASReml.
- Model used included sex and year of birth as fixed effects and age at test as a covariate.
- Breed fraction and calculated heterosis and recombination loss were included as covariates.
- Litter and test batch were included as random effects.

Description of models 2

- Genetic correlations between PPA components estimated by running multiple bivariate models between pairs of components.
- 55 models.

Heritability estimates

Component	h^2	p value
1 - Following	0.24 (0.09)	p<0.01
2a - Retrieve (stimulus)	0.21 (0.07)	p<0.01
2b - Retrieve (assessor)	**0.21 (0.07)**	**p<0.01**
3 - Restraint	0.14 (0.08)	NS
4 - Noise	0.01 (0.03)	NS
5a - Stroking (stimulus)	**0.24 (0.09)**	**p<0.01**
5b - Stroking (assessor)	**0.19 (0.07)**	**p<0.01**
6a - Squirrel (stimulus)	0.13 (0.07)	p<0.05
6b - Squirrel (assessor)	**0.09 (0.05)**	**p<0.01**
7 - Tunnel	0.16 (0.07)	p<0.01
8 - Ramp	**0.13 (0.07)**	**p<0.05**

Litter effects

- Litter effect estimates were all small but detectably larger than zero except that for component 4 (noise).
- Estimates ranged from 0.07 (s.e. 0.03) for component 2a (retrieve – response to assessor) to 0.14 (s.e. 0.04) for components 3 (restraint) and 5a (stroking – response to stimulus).

Batch effects

- Batch effect estimates were all small and not detectably larger than zero except that for component 4 (noise).
- The estimate for component 4 was 0.11 (s.e. 0.03).

Crossbreeding effect estimates

Trait	Heterosis	Recombination loss	Labrador fraction
1 - Following	0.01 (0.17)	0.13 (0.79)	-0.25 (0.34)
2a - Retrieve (stimulus)	0.08 (0.17)	**-1.62 (0.78)**	-0.15 (0.34)
2b - Retrieve (assessor)	0.01 (0.18)	-1.27 (0.81)	-0.46 (0.36)
3 - Restraint	0.01 (0.17)	-0.26 (0.73)	**0.69 (0.27)**
4 - Noise	-0.07 (0.10)	0.47 (0.41)	0.11 (0.10)
5a - Stroking (stimulus)	-0.12 (0.18)	-0.04 (0.83)	0.54 (0.35)
5b - Stroking (assessor)	0.05 (0.19)	-0.65 (0.84)	-0.58 (0.36)
6a - Squirrel (stimulus)	**-0.35 (0.16)**	-0.62 (0.72)	-0.29 (0.29)
6b - Squirrel (assessor)	-0.14 (0.16)	-1.26 (0.67)	-0.36 (0.24)
7 - Tunnel	-0.11 (0.16)	**-1.56 (0.72)**	-0.06 (0.28)
8 - Ramp	**-0.31 (0.14)**	0.34 (0.63)	0.08 (0.24)

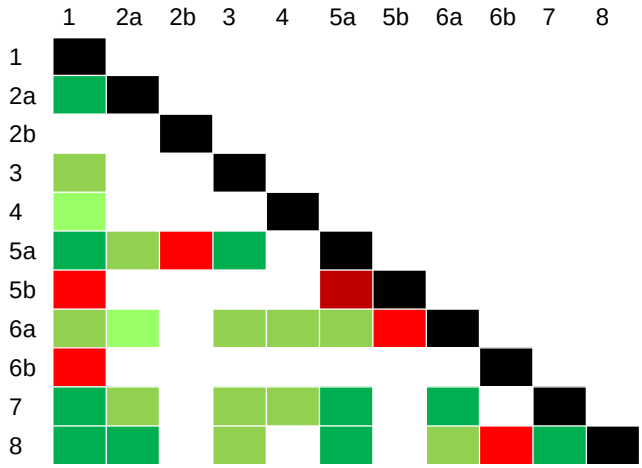
Other effects

- None of the non-crossbreeding fixed effect estimates and regression coefficients were detectably larger than zero except for PPA component 2a (retrieve – response to assessor).
- For component 2a, age at test and sex were both significant.
- Estimates of 0.04 (s.e. 0.02) for age at test and 0.14 (s.e. 0.05) for being female.

Genetic correlations

- Half of the models failed to converge or produced estimates which were not detectably larger than zero.
- The majority of genetic correlation estimates which were detectably larger than zero were moderate to large and positive.
- Antagonistic genetic correlations were identified between six pairs of PPA components.

Genetic correlations



Conclusions

- Nine of the 11 PPA components showed low to moderate heritabilities.
- EBVs for these components might be valuable for future selection decisions.
- Little evidence of beneficial or detrimental effects of crossbreeding on scores for PPA components.

Next steps

- Re-run bivariate models with additional data.
- Prinicipal components analysis, then heritability estimation and EBVs for these components?
- Selection index for PPA?

Acknowledgements

- PhD funding from BBSRC, Biosciences KTN and Guide Dogs
- The University of Nottingham
- The Animal Health Trust
- The Epidemiology of Guide Dog Behaviour Group at the University of Nottingham