Analysis of Swedish field data on dog hip dysplasia and behaviour

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Summary

In Sweden dog pedigrees, health control data, results from dog shows and all kinds of dog testing are stored in a large database kept by the Swedish Kennel Club (SKC). All this information is available for anyone as "breed data" for single breeds and may thus be used by all dog breeders in Sweden. This paper includes data on dog hip dysplasia (HD) and a special form of general mental testing, "Dog Mentality Assessment" (DMA), performed by the Swedish Working Dog Association (SWDA) since 1989. It is necessary to point out that the mental data is collected from field testing and not in a planned experiment. The intention of this paper was to analyse to what extent such data may be reliable in the selection against physical conditions and for mental performance of working dogs.

Data on HD revealed that simple combination of information from relatives will function as an effective tool I the selection against HD. The need for a BLUP-index in the selection against traits with high heritability is questioned.

Questions may be raised about the validity of tests where many judges are assessing dog behaviour. The data demonstrates however large breed differences in behaviour and analysis within breeds reveals low to moderate heritability for most of the "traits" evaluated. Mass collection of field data may thus be used as a valuable contribution in estimating breeding values based on progeny data.

Material & Methods

Material

A study on selection against hip dysplasia was performed on data comprising 89726 German shepherd dogs and 15338 Rottweiler dogs X-rayed for hip dysplasia (HD). Degree of HD was classified according to the European system for classification. Thus classes A and B, and the older class Ua in Sweden, was classified as free from HD and all the others were classified as affected.

Information about dog behaviour was collected for German shepherd and Rottweiler dogs from the DMA-testing scheme carried out by SWDA. In total over 30.000 dogs of more than 200 breeds, including in all 7445 German shepherd and 4281 Rottweiler dogs.

Methods

Data on HD is collected from X-raying dogs all around Sweden and then the degree of HD for all dogs is classified by on specialist reading the radiographs.

DMA is carried out all round Sweden and dogs are tested by in all about 240 judges using a general scheme to describe the reactions of dogs in a number of standardized tests. Originally tithe intention was to test dogs within 360-540 days of age. This restriction was however not kept for long. To avoid effect of age estimates on heritability in this paper is based only on dogs falling within the above age boundaries. For the German shepherd breed only 2200 dogs tested by experienced judges who have tested at least 60 dogs were included in the calculation of heritability of particular subtest scores.

A doctor thesis on the behavioural aspects of DMA was published by Svartberg (2003). The following description of the different subtests is quoted from his thesis.

Table 1. *The subtests in the personality test; names and short description of each test.*

Subtest	Description
Social contact	A stranger greets, walks with, and makes a brief physical examination of the dog. Variables: greeting, cooperation and handling
Play 1	The dog is invited to play with a rag by the stranger. Variables: interest in play, grabbing, and tug of war.
Chase	A small prey-like object is rapidly pulled away from the dog, who is free to run after. This is repeated once. Variables: following 1 & 2 and grabbing 1 & 2.
Passive situation	The handler remains in the same position during 3 minutes with the dog in a leash. Variable: activity.
Distance play	A stranger invites the dog to play at a distance, after some initial threat postures. Variables: interest, aggression, exploration, interest in play, and play invitation.
Sudden appearance	A human sized dummy is suddenly pulled up in front of the dog. Variables: startle reaction, aggression, exploration, avoidance (x2), and approach (x2).
Metallic noise	A chain of metal is pulled over a sheet of corrugated metal close to the dog. Variables: startle reaction, exploration, avoidance (x2), and approach (x2)
Ghosts	Two strangers covered in white sheets are slowly approaching the dog during several minutes. Variables: aggression, attention, avoidance, exploration, and contact.
Play 2	Repetition of the firs par of Play 1. Variables: interest in playing and grabbing.
Gunshot	Gunshots are fired when dog is active (playing with handler) and passive. Variable: avoidance.

Dog behaviour on each subtest is described by use of a scoring scale in the range from 1 to 5, where 1 represents a low and 5 a high intensity in the response. In the Play subtest for example a score of 1 = does not play, 2 = does not play but show interest, 3 = playing after a slow start, 4 = active in playing, quick start and 5 = playing very actively after a very quick start. There is no attempt to evaluate whether if a specific behaviour is favourable or not.

Statistical analysis

Data on HD were only classified into different groups according to the HD status of close relatives and the average outcome is presented for each of the group without further analysis of statistical significances of between group differences in frequencies.

Analysis of behaviour data was performed using standard models in two commercial statistical packages, StatView and DataDesk. The StatView package was used for standard regression analysis of progeny on parents and the GLM-procedures of DataDesk were used to test statistical significances of main effect on behavioural data. Estimates of heritability for data on behaviour were calculated by use of a special program designed by Genetica AB in accordance with procedures described by Becker (1985) for unbalanced data and with dams nested within sires.

Results

Hip dysplasia

Based on experiences from a successful selection scheme against HD at the Swedish Dog Training Centre during 1980th field data on German shepherd and Rottweiler breeding dogs gathered by SKC was divided into seven selection groups:

1. Litters after selected dogs free from HD with at least three of the parents litter mates x-rayed, all free from HD, as the grandparents.
2. As in paragraph 1 but either father or mother free from HD. No requirements on HD-status of mating partner.
3. All x-rayed dogs in the database
4. Litters after all parents not included in paragraph 1 & 2.
5. Litters with both parents from litters where at least one dog and one of the grandparents were affected by HD. No requirements on HD-status of the parents themselves.
6. Litters with father or mother affected by HD as at least one of the littermates of the affected parent and one of the grandparents.

Table 2. *Frequency of HD in litters after parents selected according to own HD-status and HD-status of close relatives*

HD-status of parents	**German shepherd**		**Rottweiler**	
	Number	**HD %**	**Number**	**HD %**
Group 1	484	13.,2	332	10.8
Group 2	10838	21.6	4049	15.6
Group 3	**89726**	**26.5**	**15338**	**16.9**
Group 4	76189	28.1	10629	17.8
Group 5	10542	31.0	958	23.8
Group 6	1354	41.6	54	33.3

There were only 6 dogs borne in litters with both parents affected by HD in the German shepherd breed and none in the Rottweiler breed.

Mental assessment

Effect of judges and age on assessment scores

In all 241 judges have been scoring dogs within the DMA-test. A special set of data including only judges who had tested at least 60 germen shepherd dogs was extracted. This set included 34 experienced judges and 3333 tested dogs. Effect of judges on scoring was significant for all subtests but tests for chase, following and grabbing, exploration and gun shot. In spite of these effects of judges there were highly significant sire effects, $P<0,0001$, on progeny data for all subtests.

A special analysis of age effect on assessment score revealed significant changes in behaviour after an age of 18 months. Older dogs showed less interest in playing and less fear and threatening reactions. Analysis in the present study was accordingly restricted to the age interval 12 to 18 month of age.

Heritability

Heritability was estimated for all subtests by use of standard procedures for intra class correlations within groups of full and half sibs. Average litter size was 4.8 and 2.4 for sires and dams of the German Shepherd breeds. Corresponding figures for the Rottweiler breeds were 8.5 and 3.7 respectively.

Table 3. *Estimated heritability for all DMA-subtests based on Sire variance component and the combined variance component for Sire and Dam. Dogs tested within 360 – 540 days of age.*

Subtest Column 2 contains references to diagrams presented in Appendix 1.	Refe-rences to diagrams 1- 6	**German shepherd Tested dogs 2200[1)]**		**Rottweiler Tested dogs 2914[2)]**	
		Sire	**Sire & Dam**	**Sire**	**Sire & Dam**
		449	449 & 874	339	339 & 773
Social contact, greeting	1a	0.35	0.18	0.17	0.23
" , cooperation	1b	0.06	0.30	0.12	0.28
" , handling	1c	0.00	0.38	0.17	0.20
Play 1, interest	2a	0.41	0.35	0.06	0.26
" , grabbing	2b	0.37	0.34	0.09	0.38
" , tug of war	2c	0.39	0.45	0.07	0.23
Chase, following 1	3a1	0.22	0.32	0.00	0.33
, following 2	3a2	0.18	.029	0.13	0.33
" , grabbing 1	3b1	0.11	0.34	0.00	0.36
" , grabbing 2	3b2	0.11	0.33	0.12	0.31
Passive situation	4	0.14	0.43	0.05	0.31
Distance play, interest	5a	0.14	0.30	0.02	0.26
" , aggression	5b	0.24	0.30	0.30	0.25
" , exploration	5c	0.28	0.30	0.19	0.33
" , interest in play	5d	0.40	0.40	0.11	0.30
" , play invitation	5e	0.26	0.32	0.08	0.28
Sudden appearance, startle reaction	6a	0.38	0.39	0.15	0.27
" , aggression	6b	0.25	0.33	0.14	0.35
" , exploration	6c	0.36	0.41	0.11	0.31
" , avoidance	6d	0.32	0.43	0.14	0.21
" , approach	6e	0.01	0.22	0.14	0.31
Metallic noise, startle reaction	7a	0.26	0.44	0.18	0.44
" , exploration	7b	0.26	0.34	0.11	0.23
" , avoidance	7c	0.00	0.43	0.19	0.29
" , approach	7d	0.18	0.42	0.18	0.48
Ghosts, aggression	8a	0.10	0.33	0.01	0.34
" , attention	8b	0.20	0.44	0.19	0.29
" , avoidance	8c	0.15	0.47	0.24	0.33
" , exploration	8d	0.20	0.29	0.04	0.28
" , contact	8e	0.27	0.38	0.25	0.32
Play 2, interest in playing	9a	0.54	0.48	0.22	0.41
" , grabbing	9b	0.43	0.48	0.07	0.38
Gun shot	10	0.04	0.18	0.04	0.17

1) Only dogs tested by experienced judges who have tested at least 60 dogs.
2) All dogs tested within an age interval of 360-540 days.

Many of the scores of the DMA test are closely correlated. I his thesis Svartberg (2003) used these correlations in a factor analysis to find personality traits in dogs. The analysis resulted in five factors named Playfulness, Chase-proneness, Curiosity-Fearlessness, Aggressiveness and Boldness. In separate studies Strandberg et al (2004) and Saetre et al (2004) made further genetic analysis based on DMA data from German Shepherd and Rottweiler dogs. Their data comprised 5964 German shepherd and 4589 Rottweiler dogs.

Table 4. *Extracted personality-factors in the DMA-test and their estimated heritability*

Personality trait	**German shepherd[1)]**	**Rottweiler[2)]**
	5964 dogs	**4589 dogs**
Playfulness	0.22	0.16
Chase-proneness	0.10	0.12
Curiosity-fearlessness	**0.24**	**0.16**
Aggressiveness	0.15	0,10
Boldness	0.27	0,25

1) Strandberg et al., 2004. 2) Saetre et al. , 2004

Discussion

Hip dysplasia

With beginning in Germany BLUP- indexes are introduced to evaluate breeding vale for hip dysplasia in dogs. According to extensive studies on HD in Sweden the heritability for the trait is rather high in most breeds with common estimates in le range 0.2 to 0.5 and for the German shepherd breed around 0.5, Swenson (1997). With high heritability, as in the German shepherd, it is of doubtful value to use complicated indexes for the selection against a trait. According to the principle of parsimony known as Occam's razor (Occam , 1285-1349) one should not in scientific modelling make more assumptions than the minimum needed. As demonstrated in table 2 above very simple combination of information from relatives will effectively reduce the frequency of HD amongst the progenies of selected dogs. Complicated index selection will introduce a risk of over evaluating index figures not properly understood in comparison with information about the dogs gathered from personal experiences but not yet possible to evaluate in simpler testing systems. Successful breeding of working dogs for a long future to come will depend on such personal knowledge about individual dogs. It is here suggested to avoid introduction of unnecessary and complicated indexes to perform simple selection tasks.

Mental assessment

DMA-test, heritability and future development

It has been shown that most of the subtests performed within the DMA-scheme show low to moderate heritability. This is in good agreement with earlier findings in studies by Wilson and Sundgren (1997) on data from the Swedish Dog Training Centre. Efficient selection for traits with low to moderate heritability should be based on progeny testing. Data from working dog competitions rarely includes progeny groups of the size needed, i.e. 15-20 dogs.

Added to that dogs taking part in competition trials are selected and thus not representative samples of progenies. The DMA-scheme was introduced to overcome these two major problems with competition data. Other major problems with the present field data remain to be solved. The large number of judges involved, in all about 240, creates difficulties in standardized scoring in spite of the simplified scoring system. A tutorial movie would probably greatly enhance the reliability of the scheme and thereby increase the heritability of individual "traits". The second drawback of the DMA-scheme is the standardized stimuli applied on each subtest. Applying too strong stimuli in a subtest would stress mentally weak dogs to hard. Too weak stimuli will not reveal which dogs have the best ability to withstand stress. This weakness of the DMA-test might be reduced significantly in a test where one uses standard steps of increased stimuli until the dog display a predifined type of reaction to the test. Until such development will take place there can however be no doubt that the present system used in a progeny testing scheme, with combination of data from full- and half sibs, will be a valuable tool for selective breeding.

Factor analysis

There are in all 33 mental scores used in the DMA-test. In table 4 they are combined into five main "personality traits" by use of factor analysis. The rather close correlations among several of the individual scores may raise the question if the testing scheme has to be as complicated as the DMA-test. If the mental reactions of the dog to different subtest is manly due to five basic traits it would be possibly to greatly simplify the test without losing valuable information. Such a reduction would shorten testing procedures and make it possible to test a larger number of dogs without the need for increasing testing time or costs. Simpler testing procedures would also be easier to standardize in cases where many judges are involved in the testing of dogs. The minor loss of information might in such cases be well compensated for by the larger number of dogs tested and the gain in stability of the assessments of behaviour.

Breed differences and problems with excessive fear

As demonstrated in figures 1-6, Appendix 1, there are large differences in the behaviour of different breeds during the DMA-test. It is especially remarkable to see the large amount of fear expressed by collies and to some extent also by Golden retrievers. In a special study the differences in behaviour between the three large retriever breeds, Flat coated retriever, Labrador retriever and Golden retriever, were compared.. The study revealed that while the vast majority of the breeding animals among the Flat coated retrievers were tested on hunting trials this was the case for only very few of the Golden retrievers. By comparing the figures 5 and 6 it is obvious that the golden breed has lost much of the basic behaviour of retrievers. In addition the Golden retriever show fear in a degree that is not compatible with successful hunting.

From unpublished enquiry studies among instructors at the working dog clubs in Sweden we know that one of the main problem at obedience training, where the owner is training his or hers first dog, is to get the owners to take command over their dogs. There is a clear tendency in our DMA-data of strong fear reactions in many breeds. The main cause might be that breeders no longer have tools to test cooperative behaviour. Selection of mentally weak dogs may be a way to avoid selling puppies that grow into problem dogs as adults when in the hands of too weak owners.

Figures 1-6. *DMA spider diagrams for 6 breeds. Axis scores from -1 to +1 compared to average for all working dog breeds (smaller inner circle). Subtest references in Table 3.*

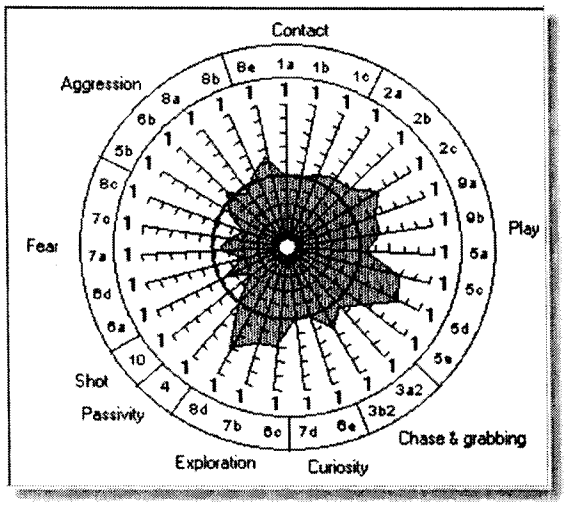

Figure 1. German shepherd (7100 dogs)

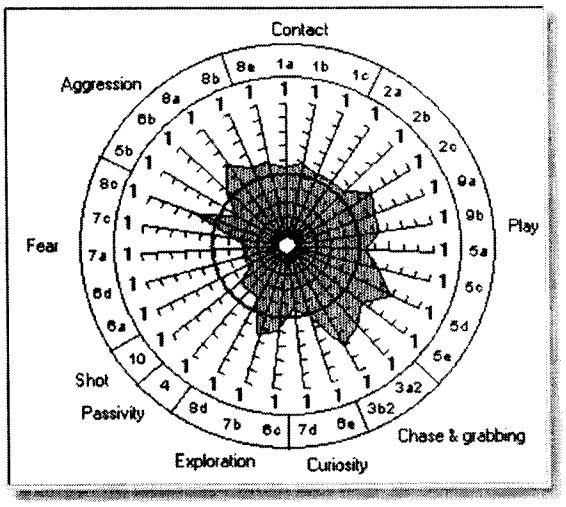

Figure 2. Rottweiler (4222 dogs)

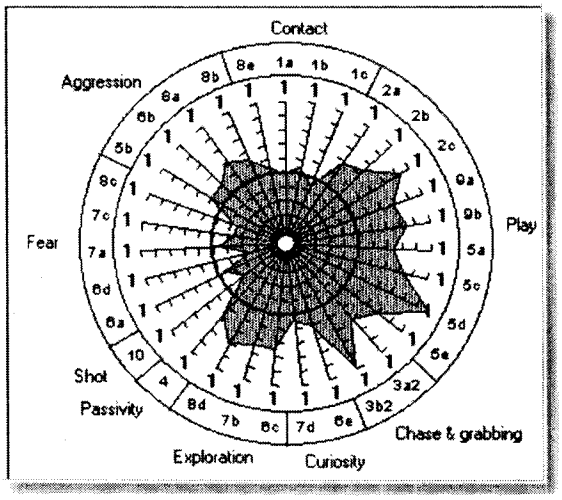

Figure 3. Malinois (485 dogs)

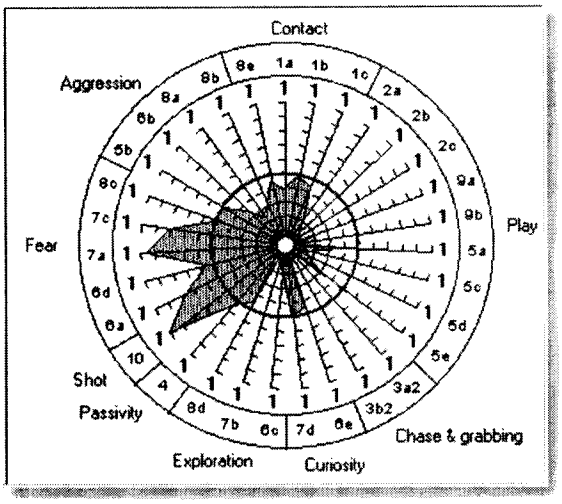

Figure 4. Collie (1038 dogs)

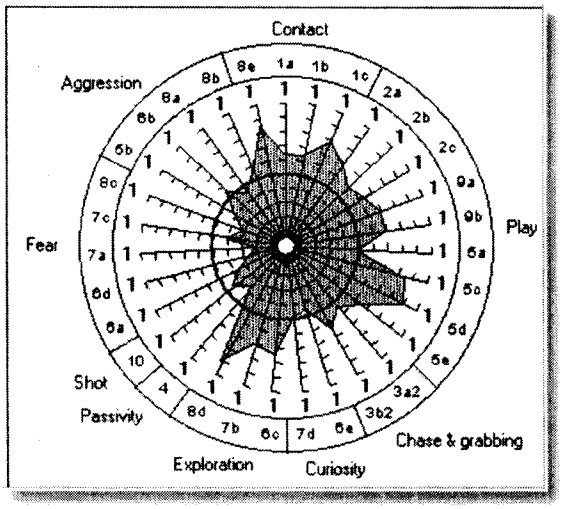

Figure 5. Flat coated retriever (609 dogs)

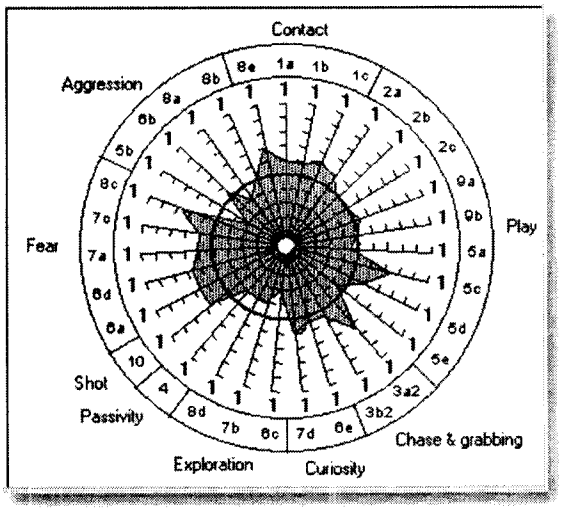

Figure 6. Golden retriever (1000 dogs)

DMA-diagrams for six breeds

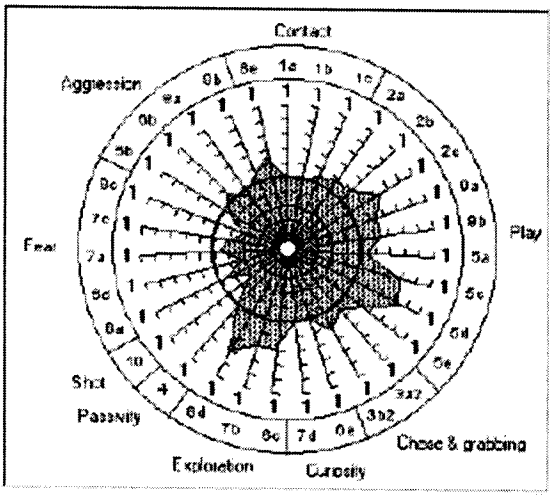

Figure1. German Shepherd (7100 dogs)

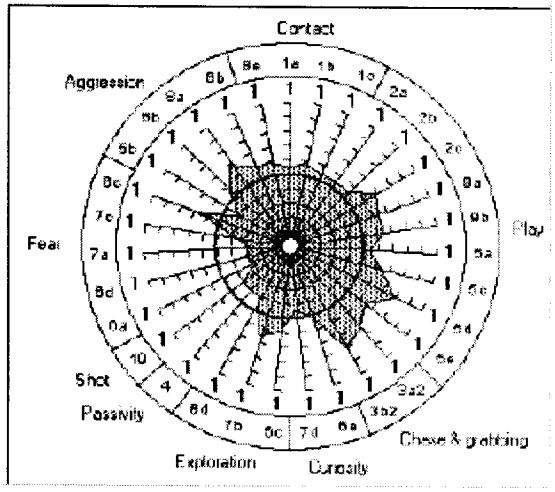

Figure 2. Rottweiler (4222 dogs)

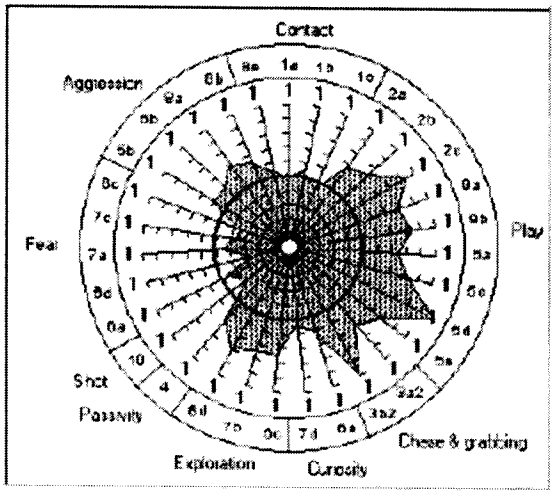

Figure 3. Malinois (485 dogs)

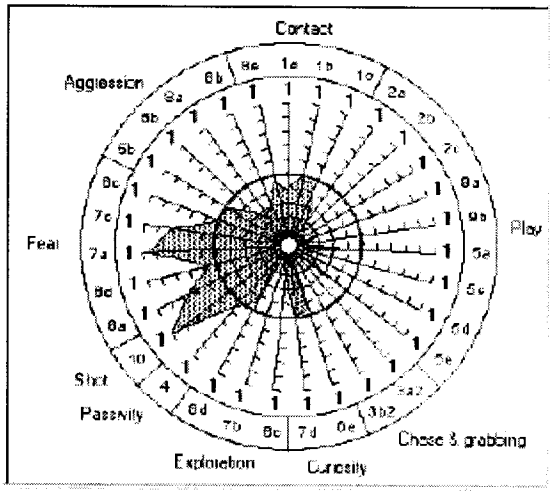

Figure 2.Collie (1038 dogs)

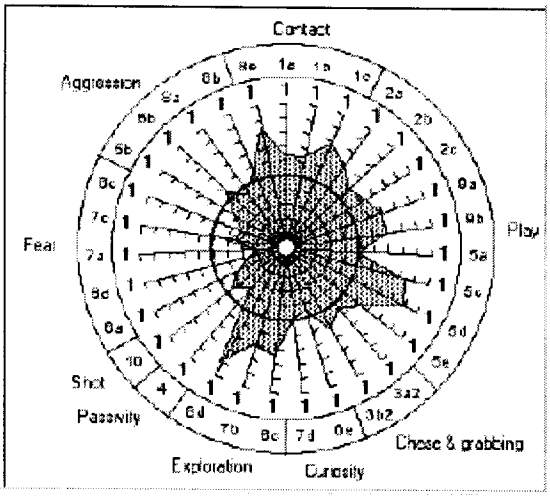

Figure 5. Flat coated retriever (609)

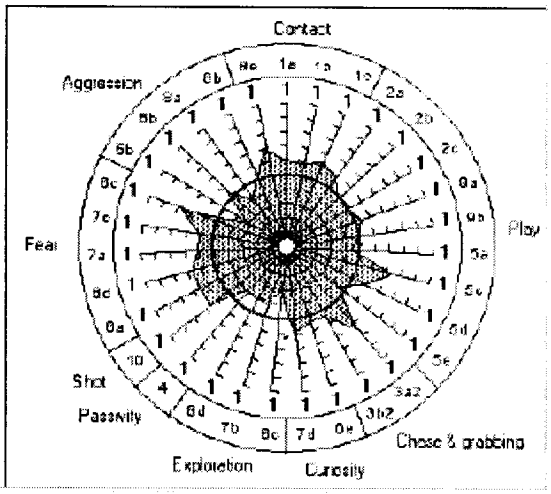

Figure 6.Golden retriever (1000)