

Genetic Linkage and Fine Mapping of Hunt and Play Behaviors in Explosives Detector Dogs

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The Dogs



- US Transportation Security Administration Canine Breeding and Development Center
 - 2002-2014
 - 4 generations
 - Quarterly testing for hunt and possession related behaviors
 - PennHip scores at 9 months
- Penn Vet Working Dog Center's Collaborative Research Agreement with DHS
 - began 2013
 - 1 litter, continuing TSA's fourth generation

Genome-Wide Linkage Analysis

- Based on the fact that sections of DNA that are closer together are inherited together more frequently than those that are farther apart
- Looks for statistical association between markers and traits, using knowledge about how genetic variations are inherited through pedigrees



Ingredients for Linkage Analysis

1. Pedigree – Knowledge of the relationships between dogs in the population
2. Genotypes – Knowledge of variation at each genetic marker
3. Phenotypes – Data on the traits we're interested in studying



Ingredient 1: Pedigree

- 348 dogs genotyped
- 3 duplicates removed
- 19 removed because of inconsistency between pedigree relationship and DNA markers
- 78 removed because relationships are too distant
- 270 total dogs



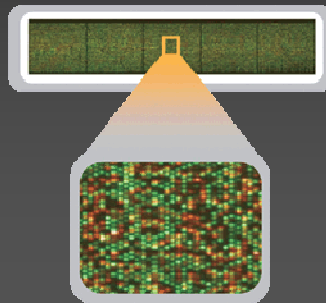
Ingredient 1: Pedigree

Sib Pair	628
Half Sibs	992
Cousin	255
Parent/Child	530
Grandparent/Grandchild	666
Avuncular	1081



Ingredient 2. Genotypes

- 164,625 autosomal markers genotyped on Illumina Canine HD array
- 53,846 markers removed due to minor allele frequency < 1%
- 874 markers removed due to Mendelian errors
- 109,905 total autosomal markers go into linkage analysis



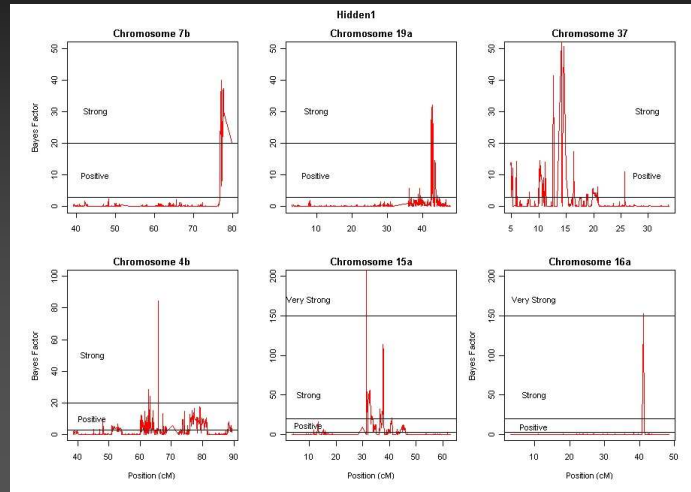
Ingredient 3. Trait Data

- Behavior testing at nine months of age
- Hidden 2 – most heritable hunt-related trait involves finding scent under a series of upside-down flower pots
- Physical Possession - most heritable possession-related trait
- Hip quality measured by PennHip score



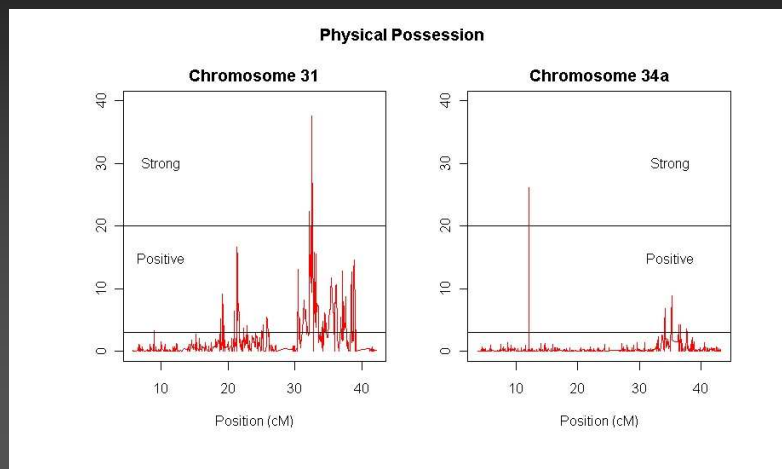
Preliminary Results: Linkage Analysis - Hidden 1

- First 88 Labradors



Preliminary Results: Linkage Analysis - Physical Possession

- First 88 Labradors



Custom Genotyping Arrays

- 1,601 markers associated with regions of interest from preliminary study
- 974 markers in and near genes thought to be involved in learning, memory, or behavior
- 116 markers in and near genes thought to be related in hip joint development and conformation
- 675 markers in and near olfactory receptors to characterize their variation in the population and possible associate them with olfactory ability
- 17 markers in or near proteins involved with olfactory receptor binding

New Puppies at the Penn Vet Working Dog Center

- First litter born June 2014
- Breeding continues to focus on health and odor detection ability
- Collection of more types of quantitative behavior data as dogs develop detection ability, agility



