



Dog Genomics vs. Breed Stereotypes

Jessica Hekman, DVM, PhD



Science is a prestigious journal.

This signals that you can have trust in the methods.

Second authors do a bunch of work
...But don't have a lot of power!

Morrill, K., Hekman, J., Li, X., McClure, J., Logan, B., Goodman, L., ... & Karlsson, E. K. (2022). Ancestry-inclusive dog genomics challenges popular breed stereotypes. *Science*, 376(6592), eabk0639.

Question 1 / 11

Shapes and Colors

How old was Jenny when you adopted her?

☐ Young puppy (under 16 weeks)

☐ Older puppy (between 4 and 11 months)

☐ Young adult (between 1 and 2 years)

☐ Adult (Over 2 years)

While imperfect, survey data collection is widely accepted as the best option for collecting large amounts of data about owned animals (16,000 dogs!).

We also
collected DNA
on 2000+
dogs.



THE MUTTMIX PROJECT

"Appearances are a glimpse of the unseen." - Anaxagoras

[About this Project](#)

[Take Pup Quiz!](#)

[Take the Pup Quiz!](#)

[About this project](#)

We asked people how they identified the breeds in mutts.

A**Biddability**

How readily dog responds to human direction, especially in the context of training
eight questions; defined by factor analysis of complete surveys for 10,253 dogs

Heritability

(1910 sequenced dogs)
 $30.5 \pm 8.5\%$ (\pm SE)

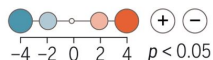
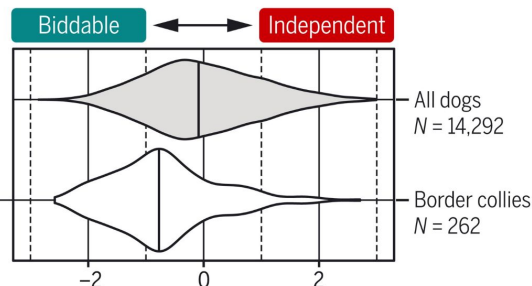
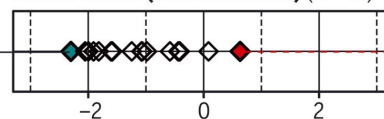
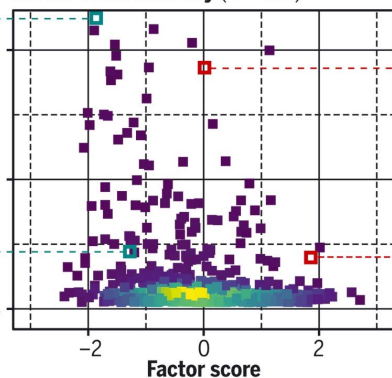
B**Top 10 most differentiated breeds:****Independent**

- + Basset hound
- + Alaskan malamute
- + Shiba inu
- + Miniature pinscher
- + Great pyrenees
- + Siberian husky
- + Beagle
- + West highland white terrier
- + Dachshund
- + Yorkshire terrier

Biddable

- Belgian malinois
- Vizsla
- Border collie
- Australian cattle dog
- German shepherd dog
- Australian shepherd
- Golden retriever
- Bernese mountain dog
- Catahoula leopard dog
- Labrador retriever

Permutation z-score

**C****D****Sprocket****Border collies (DNA confirmed) ($N = 16$)****Caboose****E****Molly****Mixed-breed dogs with border collie ancestry ($N = 638$)****Hunter****Lily****TWooie**

A

#1 Human sociability

less sociable to highly sociable

How comfortable dog is around people, especially if unfamiliar to them (17 questions)



#2 Arousal level

aroused to composed

How easily stimulated dog is across contexts, i.e. activity level & impulse control (16 questions)



#3 Toy-directed motor patterns

toy-directed to not toy-directed

How much dog displays motor patterns (e.g. grab-bite, chase), particularly towards toys (9 questions)



#4 Biddability

biddable to independent

How readily dog responds to human direction, especially in the context of training (8 questions)



#5 Agonistic threshold

assertive to diffident

How easily dog is provoked by a frightening, uncomfortable, or annoying stimulus (9 questions)



#6 Dog sociability

less sociable to highly sociable

How comfortable dog is around other dogs, especially if unfamiliar to them (6 questions)



#7 Environmental engagement

high engage. to low engage.

How interactive dog is with its familiar, daily environment (13 questions)



#8 Proximity seeking

affectionate to aloof

How readily dog solicits human contact and closeness (7 questions)



B

Does genetics matter?

Variation attributable to individual genetic differences

Are breeds different?

Difference between dogs in a breed and randomly sampled dogs

Gene mapping

Strength of top associated genomic locus? (minimum $p=1 \times 10^{-6}$)

Functional relevance

Enrichment of brain-expressed genes at associated SNPs

Does breed matter?

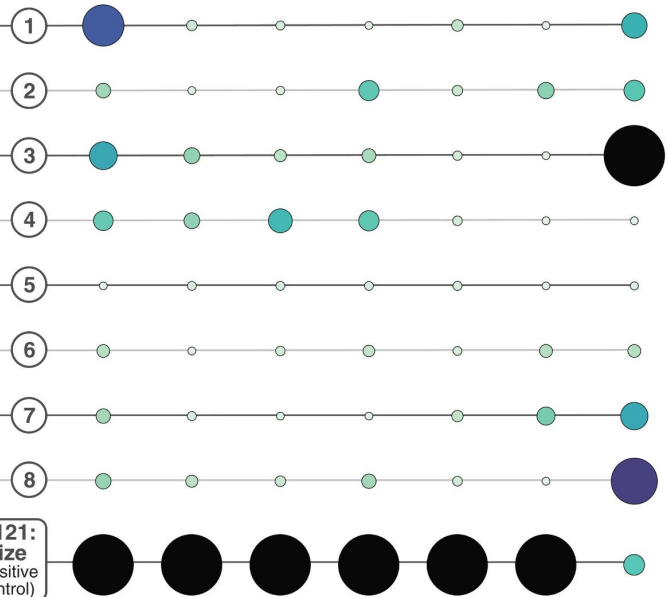
Variation attributable to breed

Does breed matter (part 2)?

Effect of breed ancestry in mutts

Evidence for past selection

Overlap of behavior loci and selection signals in breeds

test: h^2_{SNP} ANOVA PPS LMER MLMMA MAGMA

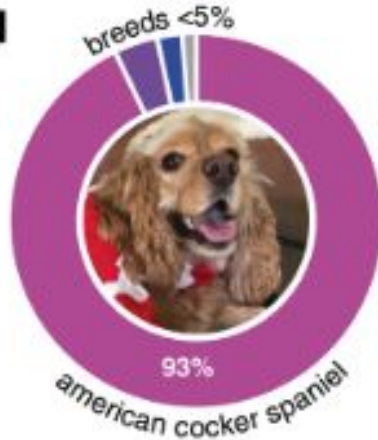
Q121: size (positive control)

Normalized score:

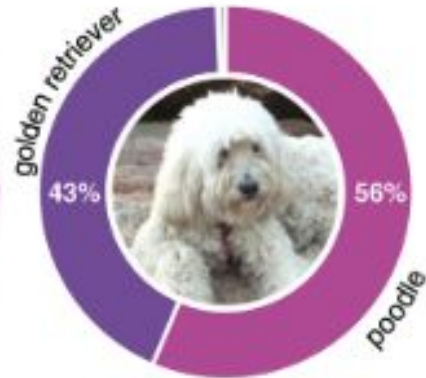
0.0 0.25 0.50 0.75 1.0

Many mutts have a *lot* of breeds in them!

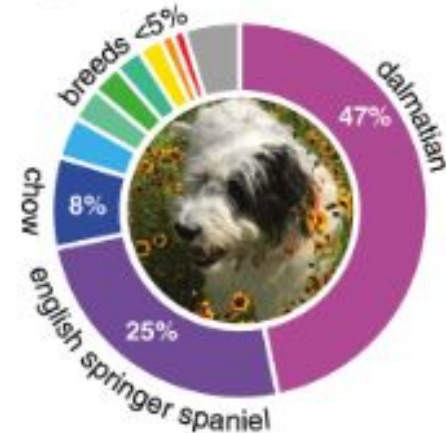
H



Caramel: Purebred



Hubble: F1 hybrid



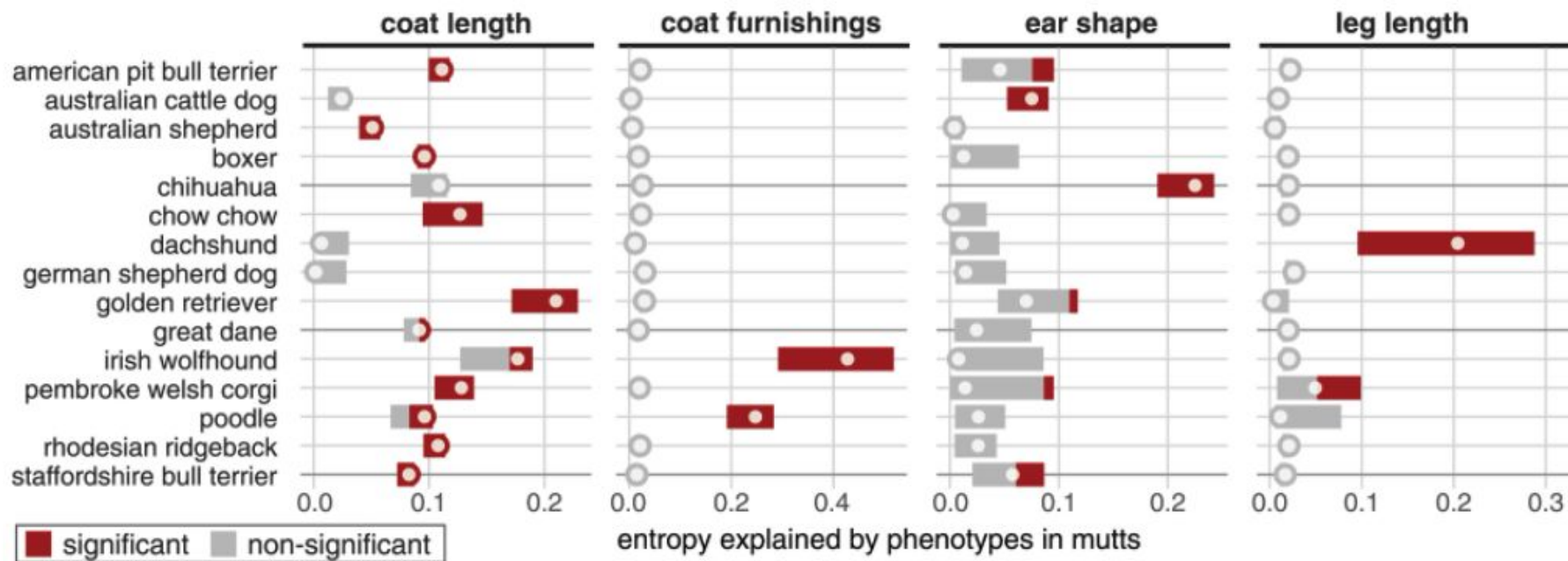
Coconut: Recently admixed



Clarence: Highly admixed

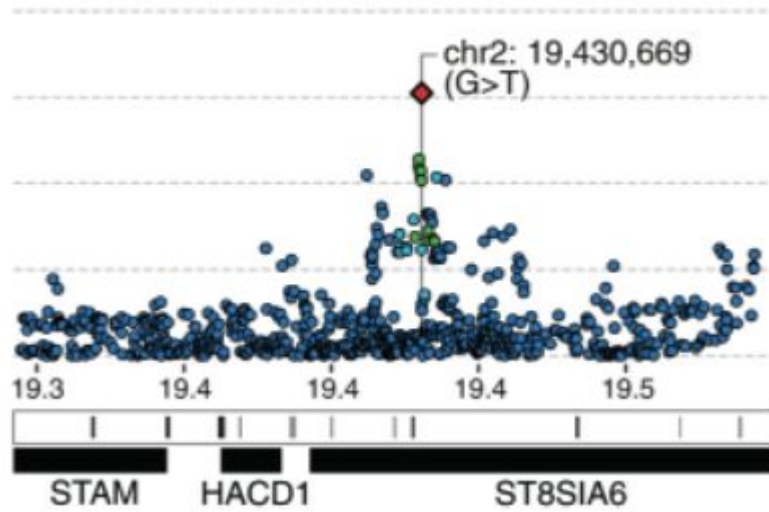
How do we identify mutt ancestry?

F

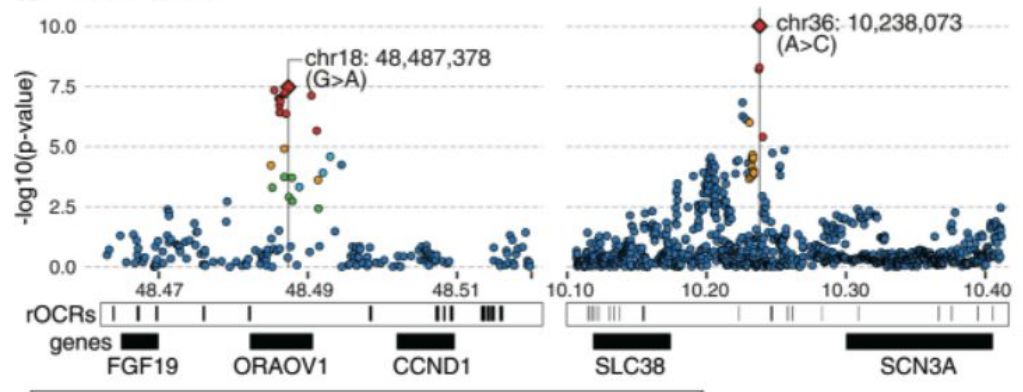


New DNA regions associated with behavior!

G Factor 1: Human sociability.



H Q17: "Howls"



Frequently asked questions

Q: Were well-bred dogs used?

A: Dogs of all sorts were used! Which helps explain our findings: do you expect a field lab to behave the same as a guide dog lab or show lab?

Frequently asked questions

Q: Does this paper say genetics don't matter?

A: Genetics are not the same as breed. This paper shows genetic influence on many traits.

Frequently asked questions

Q: Does this paper say breed doesn't matter?

A: "Matter" or "doesn't matter" aren't scientific statements. This paper has a lot of analyses. What they mean in terms of "does breed matter" is up to the individual - and there are differences of opinion.

In my humble opinion...

...breed increases the likelihood of seeing certain traits.

It is important to remember that dogs of a particular breed are not behavioral clones of each other.

Your questions?



Jessica Hekman, DVM, PhD

Mailing list: dogzombie.com

Functional Dog Collaborative:
functionalbreeding.org