Genetics and Behavior:
A Guide for Practitioners

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KEYWORDS

• Canine • Feline • Behavioral genetics • Temperament • Personality • Dog behavior • Cat behavior

KEY POINTS

- Phenotyping behavior is difficult, partly because behavior is almost always influenced by the environment.
- Using objective terms/criteria to evaluate behaviors is always best; the more objective the assessment, the more likely any underlying genetic patterns will be identified.
- Behavioral pathologies, and highly desirable behavioral characteristics or traits, are likely to be complex, meaning that multiple genes are probably involved, and therefore simple genetic tests are less possible.
- Improvement in breeds can be accomplished using traditional quantitative genetic methods; unfortunately, this also creates the possibility of inadvertently selecting for covarying undesirable behaviors.
- Patterns of behaviors within families and breed lines still provide one of the best guidelines for genetic counseling in dogs.

INTRODUCTION: WHY SHOULD PRACTITIONERS CARE ABOUT BEHAVIORAL GENETICS?

Dogs have a relationship with humans unlike that of any other domestic animal. Dogs have been selected over time for true collaborative work with humans, and this selection has historically resulted in dog breeds and groupings based on the dog's ability to work with humans on certain tasks (eg, herding). As result, most of the emphasis on behavioral genetics in veterinary medicine has been on dogs, and that bias is reflected in this article.

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With respect to domestic dogs:

- Molecular data suggest that dogs separated from wolves 10,000 to 135,000 years ago.[1–7]
- Dogs have lived together with humans for 15,000 to 30,000 years,[8–10] as supported by anthropologic evidence.[11,12]
- Breed clusters of dogs of different shapes/sizes who engaged in different tasks have existed at least 3000 years.

Only in the past 150 years has selection/breeding emphasis largely shifted from what a dog could do to how society wanted that dog to look. Dog breeds represent pools of canalized genetic variation. Historically, they have been the result of many generations of selection for certain specific tasks, and therefore it is no accident that dogs bred for conformation may have more reliable looks than behaviors, and that those bred for work may have more reliable performance than looks. Understanding this pattern and how it shapes modern genetics is important for veterinarians who wish to provide the best information about genetic factors contributing to behavior.

GENOTYPE VERSUS PHENOTYPE

We are how we behave, and behavioral phenotypes are defined by the behaviors the dog exhibits under varied conditions. All phenotypes (what the behavior looks like) are influenced by the genetic, physical, and maternal (*in utero* and rearing) environments. The behavioral phenotype of any dog is also influenced by the interaction of the environment on the dog's neurochemistry, activity of various regions of the brain, and molecular responses to stimulation, within any given genotype. This fact is why even littermates from tightly tested and controlled breeding lines can be so variable (eg, one is terrified of storms and the other is not).

The genetic background (the genotype or genomic code) of the patient only tells what could happen in terms of behavior and personality, not what will happen. The genotype is a catalog of coded sequences of instructions, not all of which will be activated, used, or expressed. This concept is essential because it means that behavior is not deterministic. Even when diseases are heritable in a simple manner, their phenotypes and presentations can be altered through interaction with the environment. Nowhere is this truer than for behavior: it occurs when pharmacologic treatment and behavior modification are used for behavioral problems, and when problems are prevented simply because the patient is in a household that may not promote them. Unfortunately, misconceptions about determinism and the role of genetics have driven myths about breed-based behaviors and unfortunate breed-specific legislation. Given these limitations, on what should we focus with respect to behavioral genetics?

All behaviors are the result of the interaction of the genetic background with the physical and cognitive environments found in the individual patient. The concept of a response surface can help practitioners understand how patterns of behavior can individually vary with exposure to different environments depending on genetic background.

The response surface in **Fig. 1** represents a simple space created by behavioral traits, the environments in which they are displayed, and the genotype affecting them. In **Fig. 1**, dogs A and B seem to behave the same (they are the same color). Their responses to different environmental manipulations will expose how they are different. As dog A is exposed to a range of environments from right to left on the environmental axis, she remains unchanged; however, when dog B is similarly exposed, her behaviors alter dramatically (B1 in **Fig. 2**).