Relationship Between Genetics and Canine Aggression

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Introduction: Canine aggression has always been a concern for pet owners. Aggression can be very dangerous and even life threatening for humans, other animals, and the dog itself. Not only is aggression dangerous, it is a huge liability for pet owners as well because many landlords have strict pet policies that may lead to anything from large fines to the loss of their home. On average, 10% to 15% of dogs that are euthanized are done so because of problems with aggression. Thus, aggression is a major issue for the welfare of canines that needs to be addressed because the understanding of it has the potential to save many lives. There is some evidence that part of the problem may be somewhat out of the control of the pet owner, which is the genetic basis of some types of aggression. One of the strongest pieces of evidence that suggest a dog's behavior can have a genetic basis is the domestication of wolves to eventually become today's dogs. Humans selected the friendlier wolves to live amongst them, which allowed the less aggressive dogs to thrive. As generations passed, the wolves became more and more friendly until they ultimately became man's best friend. This theory was given some proof when it was repeated with the fox in Russia. The existence of breed stereotypes, such as that of the Pitbull or the Rottweiler, is also a strong indicator of the fact that there has always been a belief that aggression sometimes has a genetic basis; however, research is indicating that there may be some fact behind these stereotypes. Genetics has become a booming field of science in the modern era and recent studies have indicated that there is evidence that genetics plays a role in aggressive behavior in at least some cases.

Purpose: Due to the large portion of dog's being euthanized annually and the threat these dogs pose to society because of aggressive behavior, discovering the cause of this issue could potentially be used to help prevent or treat these problems. It is believed that once the genetics of canine aggressive behaviors is understood, this information can be used to help influence selective breeding of dogs to decrease or potentially eliminate aggressive behavior.

Procedure: Data was compiled from peer-reviewed articles that discussed relationships to aggressive behavior and certain phenotypes, the heritability of aggressive behavior, and analysis of the certain genes suspected to be associated with aggressive behavior. This information was compared in order to determine whether or not there are phenotypic trends in aggressive dogs (ex. Coat color) that would suggest that there is a genetic link to aggression, as well as more direct evidence that experimented on certain suspected genes. Comparison of similar studies was used to demonstrate consistency of the results

Results:

Breeds: Trends between aggressive behavior and the breed of the dog were observed in several studies. Dominance aggression was most commonly observed in the English Springer Spaniel, Doberman Pinscher, Toy Poodle, and the Lhasa Apso, though it also occurred very infrequently in dogs of the hound group [3]. Akitas, Jack Russel Terriers, and Pitbull Terriers were found to be 20% more likely to exhibit dominance aggression towards new dogs in particular [12]. Protective aggression is found most commonly in working dogs, especially the German Shepherd. German Shepherds are also most likely to exhibit fear-elicited aggression, though it also commonly occurs in Cocker Spaniels and Miniature Poodles. Chihuahuas, Dachshunds, and Jack Russel Terriers are the most common breeds to exhibit the types of aggressive behaviors that are directed towards both humans and dogs [3]. The breeds with the lowest incidence of aggressive behaviors towards humans were found to be the Golden Retriever, Labrador Retriever, Bernese Mountain Dog, Brittany Spaniels, Greyhounds, and Whippets. Dogs bred for show quality were also observed have more cases of fear aggression whereas dogs bred for field work were found to be more likely to have dominance or predatory aggressive behaviors [5].

Gender: Gender also appeared to play a role in the emergence of aggressive behaviors. Dominance aggression and intra-specific aggression were found to vary the most between the sexes, while fear-elicited and predatory aggression demonstrated the least variation. Intra-male aggression is observed more than intra-female aggression, and males are more likely to exhibit other forms of aggression as well. Approximately 67% of males were found to have at least one type of aggression, as opposed to only 32.6% of females. Males will also display aggressive behaviors to both sexes, while females typically only act aggressively toward other females. The castration status of the animal can also influence aggression [3].

Coat Color: Genes for coat color may be related to the observation of aggression in a dog. Variations in the tendency for dominance aggression differed within the three possible coat colors of cocker spaniels. The puppies with the golden coat had the most cases of dominance aggression, followed by the black coat and the particolored coats, respectively. The solid colors for this breed are more natural than the particolored coat, but displayed significantly more aggression. The researchers concluded that the gene for dominance aggression may be in close proximity to the gene for coat color and has a heritability of 0.2 [10].

Genes Involved: Currently, there are some genes that have been theorized to be involved with aggressive behaviors. It is known that behavior is a consequence of central nervous activity. It is suspected that the genes involved will be in noncoding and regulatory regions of the gene sequence [11]. Genetic associations with aggression have been found in the alleles of DRD1, HTR1D, HTR2C, and SLC6A1, which are all associated with a neurotransmitter-related gene. Polymorphisms in DRD1 have been shown to be contributing factors in psychotic behavior, as well as aggression in a study on Alzheimer's disease patients. HTR2C has been shown to suppress aggressive behaviors when stimulated in the prefrontal cortex. There is some evidence that these two alleles may work in conjunction with one another, but the mechanism for this is not currently understood. SLC6A1 is important in the regulation of central GABAergic activity, so because GABA is important in the inhibition of aggressive behavior, problems with these alleles will limit GABA's inhibitory capabilities. Although HTR1D was found to have an effect on aggressive behavior, the reason for this is not known [7].

Genes located in the hypothalamus are also suspected to play a role in aggression because it is involved in controlling specific endocrinological and emotional responses. In a study comparing the genes of domesticated dogs and those of wild canids, the latter were found have conserved genes for the hypothalamus, while the domesticated dogs were divergent [8].

Mutations: Mutations in serotonin-related genes have also been a suspected cause of aggressive behavior. The genes in particular are HTR1A, HTR1B, HTR2A, SLC6A4 because of their involvement in serotonin metabolism. However, there were no differences in these specific genes found between aggressive and nonaggressive dogs.

Types of Aggression	Related Traits
Dominance Aggression	Breeds (English Springer Spaniel, Doberman Pinscher, Toy Poodle, Lhasa Apso); males; Cocker Spaniels: coat color
Protective Aggression	Breeds (Working Dogs (esp. German Shepherd))
Fear-Elicited Aggression	Breeds (German Shepherd, Cocker Spaniel, Miniature Poodles); Show Bred Dogs
Human and Dog Directed Aggression	Breeds (Chihuahuas, Dachshunds, Jack Russel Terriers)
Predatory Aggression	Breeds (Working Dogs)
Intra-Specific Aggression	Sex

Type of Aggression	Heritability
Human-Directed	0.77 [9]
Dog-Directed	0.81 [9]
Dominance	0.2 [10]

Studied Genes	Effects on Animal
DRD1 (serotonin-related)	Polymorphisms have psychotic effects and cause aggression
HTR2C (serotonin-related)	Suppresses aggressive behavior when stimulated
SLC6A1 (serotonin-related)	Associated with GABA aggression inhibition
HTR1C (serotonin-related)	Thought to alter aggressive behavior (Reasons unknown)
CLN5	Base pair deletion causes neuronal ceroid lipofuscinosis with aggressive behavior as a side effect [5,6]

Discussion: Genetics is still a fairly new field of science that is currently under heavy research. The study of the genetics behind behavioral disorders is behind in comparison to other diseases because of the complexity from which they occur. Aggression is thought to be the cause of multiple genes, making it more complicated to identify the group of genes involved. This behavior is difficult to study as a whole because even when genetics are involved, the environment usually plays a role in it as well. It becomes difficult to determine when a dog may be aggressive because of their genetics, their environment, or both [9]. Analyzing any behavior remains somewhat subjective and cannot be truly quantified, making accurately defining and measuring behaviors nearly impossible. There are no standardized tests for evaluating aggression and much of the data researchers use comes from owner's opinions. Studying aggression in dogs is especially challenging because many animals are euthanized before research can be completed because of the dangers that they pose to the owners and/or researchers. Owners often surrender or euthanize dogs without attempting treatment or testing, which decreases the available subjects for research [2]. Thus, there are still many challenges that researchers must overcome before developing an understanding of how genetics play a role in aggressive behavior.

It has been demonstrated in several different studies that some types of aggression are genetic based. Behavioral genetics is a very new field and there are still a lot of unanswered questions. Aggression has been shown to vary between breeds and genders, as well as occurring when genetic mutations occur. Different types of aggressive behaviors have been demonstrated to occur at increased rates in some breeds and some have been shown to be more heritable than others. The gender of the dog can also greatly influence whether or not a dog will have certain types of aggression. Mutations are theorized to be the cause of some aggression problems, though current research to prove this is very limited. Certain genes have been theorized to be partially responsible for aggressive behavior, but the extent to which they influence aggressive behaviors is still to be determined. It is still undeniable that the dog's environment and history are also major factors in the emergence of aggressive behaviors. The desire to understand the complexity behind these behaviors is strengthened by the perceived benefits. The hope is to develop enough of an understanding to help prevent aggression in the future in order to ensure the safety of people, other animals, and the dog itself. Canine aggressive behaviors have been proven to be attributed to a genetic background in part and with new discoveries and knowledge in genetics, it is becoming a growing area of research.

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