Applied Dog Genomics

Breed Analysis, Origin Stories, and the Puzzle of Mixedness

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Abstract: While the concept of interspecies kinship foregrounds partial connections across species difference, breed as a form of cultivated subspecies difference is also reckoned with as people seek to understand and care for their companion animals. This includes those whose companion animals are defined as mixed breed. This article explores the continued salience of breed as a way of knowing companion dogs in a context in which purity and pedigree is no longer the dominant framing of their value. It does so through a focus on companion dog cultures in the US and new forms of breed knowledge that are offered by genetic tests that provide a breakdown of the breeds in a mixed-breed dog's background. In this applied science of canine genetics, the mixed-breed is made into a new resource for extracting profit, through the suggestion that people's care for and relationships with their mixed-breed dog are enhanced by knowing their breed background. This promise depends, however, on eliding the complex and contested significance of breed for understanding dogs, both in canine behavioural science and among dog people. Investigating what lies behind the familiar question of "What breed is your dog?" through a focus on these tests suggests that interests in knowing the breeds in a mixed-breed dog reflect the continued cultural hold of modern breed imaginaries of fixing and mixing—the appeal of named and contained categories of dog diversity and fascination with the outcome of crossing—and with origin stories, not only for people, but also for dogs.

Keywords: *interspecies kinship, breed, companion animals, dog breeds, canine genomics, dog breed analysis tests*

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How might breed matter to the way people understand and relate to an animal that is not located within a single breed category? Since 2009, when they were first launched in the UK and US, genetic testing companies have been selling tests which offer to estimate the proportions of different breeds in a mixed-breed dog's ancestry. They do so on the basis that this form of breed knowledge matters and is worth knowing. Their customers are predominately dog owners in North America and Europe who include dogs within their homes and lives.[1] These are the dogs conventionally known as pets, or, increasingly in Anglophone contexts, as companion animals (a term that avoids the connotations of subordination and ownership associated with "pet" and acknowledges the significance of intimate human–animal relationships and subjectivity of the nonhuman animals within them).[2] This is potentially a large market. It is estimated that fifty-three per cent of the approximately eighty million companion dogs in the US are mixed-breed or "mutts"[3] and thus not eligible to be registered in the American Kennel Club (the predominant breed registration

1 At the time of writing, the sector is dominated by ten companies that offer genetic breed analysis and potential genetic disease tests for cats and dogs. Roughly two thirds of the market is in Europe and North America where is it predicted to grow along with smaller but also growing markets in Latin America, Asia Pacific, the Middle East, and Africa. The marketing of tests to predict susceptibility to genetically inherited disease to breeders and owners has been subject to some critical attention (see Moses et al., "Pet Genomics Medicine". See also Zhang, "What Vets Think". Though canine breed analysis tests are only relevant to owners of mixed-breed dogs their sales generate a significant proportion of revenue in the sector (see Grand View Research, *Pet DNA Testing Market*). Breed ascertainment tests cost approximately 100 USD but more if combined with health screening.

2 In academic work, this use derives from Haraway's work on companion species in *When Species Meet*. More widely, animal rights organizations reject the term "pet", and "companion" is increasingly used alongside other terms such as "furry friend" in US and other Anglophone dog cultures. Alternatives to "owner" with its associations with property and power exist—such as guardian or caregiver—but none dominate, and the term "owner" remains integral to US dog and wider animal legislation ("Ownership vs. Guardianship").

3 I use the term "mixed-breed" to refer to non-pedigree dogs in the US and other Anglophone countries, rather than non-breed as used by Susan McHugh in her account of the shifting cultural association of "mutts". This is because the mixed can be the product of intentional breeding, as well as of dogs reproducing outside human control, and because non-breed includes local "village" or "street" dogs in places where dogs routinely live alongside but not with people. McHugh, *Dog.*

organization in the country).[4] Genetic breed analysis tests have become relatively well-known among dog owners, breeders, and veterinarians, and they increasingly feature in the everyday conversations that occur between dog owners and dog enthusiasts in response to the familiar question: "what breed is your dog?"

Focusing on companion dog cultures and the application of canine genomics in the US, this article adds to research addressing the economic and socio-cultural significance of animal breed epistemologies and practices.[5] It does so by addressing the salience of breed to people's understandings of dogs and human–dog relations through my focus on this novel commodification of breed knowledge. As I will argue, in this applied science of canine genetics, the mixed-breed is made into a new resource for extracting profit, through the ways in which companies borrow the strategies of human genetic ancestry testing services in a context in which genealogical and genetic origin stories are an enormously popular exploration and expression of personal identity. These tests promise intensified human–canine kinship to mixed-breed dog owners by suggesting that people can "know" their dogs more intimately if they know their breed background. This depends, however, on eliding the complex and contested significance of breed for understanding dogs, both in canine behavioural science and among dog people. In practice, as I will explore here, the test results supply a limited, but nevertheless valued, breed "back-story" for mixed-breed dog owners who are asked "what breed is your dog?" The sense that many owners have of the need to be able to answer the question, and the impulse to ask it, testify to the ways in which dog breed imaginaries continue to frame how people see dog diversity and individuality.

Recent work on the way in which breed as a way of knowing non-human animals—that is, as members of collectives created through controlled and selective breeding, defined by their genealogical relations and embodiment of breed standards—shapes relations with

4 American Veterinary Medical Association, *U.S. Pet Ownership*. This is similar to estimates of mixed-breed dogs in Australia. The figures for Germany and the UK are thirty-one to thirty-three per cent (Turcsán et al., "Owner Perceived Differences").

5 Guest et al., "Humanimalia Roundtable".

individual animals has opened up important avenues for addressing the nature and practice of interspecies kinship, including, but not limited to, human–companion animal relations.[6] While the concept of interspecies kinship foregrounds partial connections across species difference,[7] breed as a form of cultivated *subspecies* difference is also reckoned with as people seek to understand and care for their companion animals. I draw on, and extend, this work and my own engagements with breed purity, biocultural heritage, and kinship,[8] by exploring how people's reflections on the significance of inherited characteristics are not limited to those whose animals are pedigree breeds. I do so also by bringing a geographical analytical approach to my consideration of breed and companion animal kinship. This approach is both conceptual and contextual, concerned with the geographies of the enclosure, commodification of canine diversity, and the spatiality of breed origin stories, epistemologies, and imaginaries. It is attentive to the particular geographies of companion animal cultures and the global flows that serve them. I deploy this analytical lens in the first section of this article to situate mixed-breed dogs within historical and contemporary geographies of the making of breeds and wider categorizations of canine diversity, and to consider recent engagements with the significance of breed to interspecies kinship. In the second section, I address the nature of breed analysis tests for mixed-breed dogs, their relation to canine genomics, and the ways ideas of breed and kinship are deployed in the companies' claims about their value. I focus particularly on the two US-based companies that dominate the sector—*Embark* and *Wisdom Panel*—and examine them through a qualitative analysis of their websites and by tracing the commercial, scientific, and socio-cultural context of their development.

In the third section, I consider the relationship between these claims of value and the significance of breed for understanding the behaviour and needs of individual dogs in canine behavioural science and

6 See, for example: Bolender, "If Not for Her Spots"; Haraway, *When Species Meet*; Nash, "Valuing Difference"; Weaver, "'Becoming in Kind'".

7 Govindrajan, *Animal Intimacies*; Haraway, *When Species Meet.*

8 Nash, "Breed Wealth"; Nash, "Kinship of Different Kinds"; Nash, "Valuing Difference".

in wider society. My focus is on the significance of breed difference to owners of mixed-breed dogs, and to dog enthusiasts more widely, for whom the purity, continuity, and ownership of recognized breeds does not define their interest in dogs. I explore how these new forms of breed knowledge provided by tests relate to the ways people work through the relative significance of breed-specific behavioural characteristics, ideas of appropriate training, their dog's individuality and the different weight given to these factors in canine behavioural science and by dog experts and enthusiasts. What kinds of significance can breed have for human–companion animal relationships when breed mixture, rather than purity, defines a companion dog? The answers that I offer come from engaging with media accounts of the tests, existing published analyses of customer perspectives, expert commentaries in the US context, and international research in canine behavioural science. As I will explore, for those with mixed-breed dogs, and those interested in dogs more widely, breed matters but not necessarily in terms of care and kinship. Breed matters because it continues to frame how dogs are understood through these categories of difference. It underpins the appeal of creating new forms of difference in the offspring of mated dogs, even if only as an imaginative exercise, and figuring out the puzzle of mixedness.

Canine Categories and Kinship

Addressing the particular significance of breed to understandings of, and kinship with, nonhuman animals is vital given its implications for those relations and for animal lives. Yet breed, as a subspecies category of difference, also needs to be considered in relation to other profoundly significant, if unstable, categorizations of animals (such as species taxonomies and designations of wild, domestic, feral, native, or invasive).[9] A starting point for addressing the figuring of breed in genetic breed ascertainment tests is to locate mixed-breed companion dogs in conventional classifications of canine diversity, as well as in US dog cultures more broadly.[10] Doing so foregrounds

9 Ritvo, "Species"; Ogden, "Beaver Diaspora"; Keil, "Unmaking the Feral".

10 The term "US dog cultures" signals plurality within the national. Attitudes to dogs vary within as well as between countries in relation to religious and cultural difference, and racist disapproval is directed to those perceived as not conforming to dominant

the situatedness of the cultural assumptions and the geographical imaginaries that underpin categories of dog difference, not only in terms of breed and breeding practice, but also in terms of the spaces dogs inhabit during their lives. The designation "mixed-breed" depends on its contrast to the concept and practices of pedigree dog breeding. But before turning to the particular cultural salience of the mixed-breed, it is worth situating these dogs within the category of the companion dog and considering how this category shapes cultural and scientific conventions for describing global canine diversity.

The typologies of dogs developed by canine scientists in countries in which companion dogs are the unconsidered norm usually measure other dogs' lives against what is, in fact, the historical and geographical exception of modern dog breeds and the specificity of modern western companion dog culture.[11] Mixed-breed domestic companion dogs in advanced capitalist economies, whose ancestries are the focus of genetic breed testing, are situated within the minority of human–dog relationships and dog lives historically and globally; it is estimated that seventy-five to eighty per cent of dogs in the world are free roaming, rather than companion animals.[12] As Jeremy Koster puts it, most dogs in the world are not neutered, alimented (that is fed commercial dog food), trained, isolated (alone within the home when owners are out), vaccinated, and engineered (that is, "bred").[13] Yet, the colonial-modern creation of dog breeds (defined by pedigree lineage and human-controlled reproduction according to breed standards) in Europe in the nineteenth century continues to shape how global dog diversity and human–dog relations are understood. This is reflected in the way dogs are conventionally, if controversially and not very accurately, differentiated globally into three broad categories in terms of the nature or absence of human breeding: "modern breed dogs", such as the Golden Retrieve or Jack Russel Terrier; "ancient breeds" that were initially bred in other places

attitudes to dogs or dog-keeping practices. See Kharputly, "Whose Best Friend?"; Jervis et al., "Protectors, Aggressors, and Kinfolk".

11 Serpell, "From Paragon to Pariah".

12 Koster, "Most Dogs"; Bryce, "Dogs as Pets"; Lord et al., "Differences in the Behavior".

13 Koster, "Most Dogs", 110.

before modern European breeding but not with "modern" methods, such as the Saluki or Basenji breeds; and "free-breeding" dogs.[14] This third category contains "street", "village", or "feral" dogs, who are defined spatially in terms of their difference from dogs who live with people in their homes as "pets". Such dogs are also separated from other types by functionality, as they are often defined as "pests" in contrast to working or companion dogs. The view of the companion dog as the norm against which other dogs are defined is challenged by Raymond and Lorna Coppinger, who insist that the village dog is the norm for dogs worldwide, while pure or mixed-breed dogs are the exception.[15] Similarly, Susan McHugh points out that most dogs have an "overwhelmingly non-breed genealogy".[16] Nevertheless, the companion-dog model remains dominant in the minority dog world.[17] This effects how other forms of human–dog relations are imagined. Idealizing human–companion dog relationships as ones of intimate intersubjectivity and mutual affection inaccurately implies the absence of care and relatedness in other configurations of human and dog lives.[18]

14 Boyko and Boyko, "Dog Conservation".

15 Coppinger and Coppinger, *What Is a Dog*.

16 McHugh, *Dog*, 129.

17 I use the term "minority dog world" to refer to wealthy Western countries where the conventional model of companion dog ownership dominates. Yet the geographies of companion dog cultures are complex and as with any broad categorization this risks overgeneralising within and between categories of difference. Increasing numbers of dogs live as companion animals in wealthy homes beyond the minority dog world as companion dog ownership has grown in popularity among the middle-class especially in Brazil, China and India. Furthermore, a simple model of the globalization of companion dog ownership, along with European breeds, as a status symbol elides the diverse and shifting entanglements of class, culture, and "traditional" and "modern" dog-keeping practices in different majority (dog) world contexts. See for example Dande, "A City Gone to the Dogs?"; Dande, "The Political Economy".

18 Bryce, "Dogs as Pets". In practice, the labour that dogs do, and the nature of human-working and -companion dog relationships, do not neatly conform to distinctions between companion, working, and street or village dogs. As Koster argues, anthropological research demonstrates that these categories cannot describe the huge variety of ways in which dogs and humans live with and interact with each other in different cultural, socio-economic, and environmental contexts. This includes those in the US and other high-income countries experiencing homelessness who share their lives with companion dogs, and for whom their relationship with their dog constitutes home. See Gillespie and Lawson, "'My Dog Is My Home'".

This mode of figuring global dog difference through categories based on differentiated forms of breeding, and on the place of dogs (in or outside domestic spaces), intersects with the geographical constitution and globalized nature of pedigree breeds. Despite their definition as genetic and morphological categories, breeds are geographically made and imagined.[19] In the companion dog cultures of wealthy European and European settler-colonial societies, mixed-breed dogs are defined against "modern dog" breeds with their largely European origins and now global reach.[20] Of the three hundred and sixty or so internationally recognized dog breeds, many are overtly associated with their place of breed origin.[21] All pedigree breeds have an official country of origin and a more specific origin story developed by those who worked to enclose and codify canine diversity and ensure breed containment and continuity through pedigree and breed standards.

However, breed origins do not always correspond to singular places. While most pedigree dog breeds are European in origin, many breeds that were popularized in Europe were partially developed through obtaining dogs from other places. Furthermore, those who want to, and can afford it, can acquire dogs of pedigree breeds that originated anywhere in the world, as the global economy in these "lively commodities" has expanded.[22] Thus, pedigree dog breeds, like industrially farmed animals, can embody specific, and often entangled, geographies in their making and global mobility.[23] These historical and contemporary cultural and economic geographies of breeding are also responsible for producing dogs of mixed breed ancestry.

Like purebred dogs, mixed-breed dogs in US dog cultures have origin stories that contain multiple threads, extended geographies, and global companion dog economies that together result in the making

19 Woods, *Herds Shot Round the World*; Nash, "Bread Wealth".

20 Ritvo, "Pride and Pedigree"; Worboys et al., *Invention of the Modern Dog*.

21 The Federation Cynologique International, the largest international federation of kennel clubs, recognizes 359 dog breeds. "FCI Breeds Nomenclature", *Federation Cynologique International*, https://fci.be/en/Nomenclature/Default.aspx.

22 Collard and Dempsey, "Life for Sale?"; Ray and Gulley, "Place of the Dog".

23 See, for example: Quick, "Making of a New Race"; White, "From Globalized Pig Breeds".

of human and canine categories of difference.[24] As McHugh argues, in Europe the history of the mixed-breed dog is one of class-based distinctions between bred dogs and "mongrels", who, as a group of unpedigreed dogs in urban contexts, were demonized as sources of disease, constructed as symbols of disorder, feared as threats to impurity, and associated with human vagrancy. In European colonial settler contexts, these distinctions became racialized through the association of high-status bred dogs with white settlers and of colonized or racialized people with the "inferiority" of other dogs. Indeed, the mating of pedigree and local dogs was often characterized as miscegenation.[25]

Within present day US dog cultures, the celebration of pedigree continues, to a certain extent, and traditional pedigree breeds remain popular, often rising to new popularity through their associations with celebrities or through the "stardom" of film and TV dogs.[26] However, the cultural salience of the mixed-breed has also shifted. Mixed-breed dogs are now firmly part of the minority dog world, and purity of breed is no longer the dominant framing of value. Even those in the historically pedigree-focused breeding industry often approach the subject of purity in ways that adopt a less restrictive stance towards the role of non-pedigreed animals within breeding programs. For instance, proponents of responsible pedigree breeding advocate for, and invest energy in, addressing the hereditary health issues of pedigree dogs through breeding programmes that, in some cases, include careful cross breeding, thus prioritizing preservation and improvement over absolute purity.[27] This is paralleled by the fashion that emerged in the 2010s for new "designer breeds" produced through crossing

24 The sematic crossovers, naturalizing effects and distinctions between race and breed, have been subject to critical scrutiny. See, for example: Rosenberg, "No Scrubs"; Quick, "Making of a New Race"; Derry, "Purity".

25 Zelinger, "Race and Animal Breeding", 382.

26 Ghirlanda et al., "Dog Movie Stars".

27 Włodarczyk characterizes this as a crisis of the modernist breeding project to emphasize the radical nature of this shift. However, cross breeding supplements rather than supplants the primacy of pedigree in delimiting old breeds and new hybrids breeds (Włodarczyk, "Postmodern Breed").

pure breeds, whose names splice together portions of the pedigree breed names, as in Labradoodle or Cavapoo.[28]

As this development suggests, the cultural connotations associated with mixedness have shifted; ordinary mixed-breed dogs are no longer seen necessarily as the inferior counterpoint to pedigree dogs. In contrast to the figuring of mixed-breed dogs as crude, worthless, and inferior in comparison to the purebred animals, mixed-breed dogs are now often associated with positive values of purported hybrid vigour and the egalitarianism of the ordinary and lowly "underdog" who is loved as an individual rather than for her pedigree. This anti-elitist association has echoes in the cultural figuring of the mixed-breed stray dog in European and North American cities that emerged alongside, and as a counterpoint to, the valorisation of dog purity and pedigree in the late nineteenth century, in which accounts of these lowly dogs became a means to critique social injustice and inequality.[29] Today, these connotations of "impure" status are often celebrated in mixed-breed dog clubs and events. Even within the traditional bastions of pedigree breeding, the breed associations, mixed-breed status is gaining new footholds. For instance, while committed to the continuity of established breeds, the American Kennel Club (AKC) allows non-pedigree dogs to compete in AKC competitive events within the category "All American Dog".[30]

Choosing to have a mixed-breed dog can reflect people's ethical antipathy to ideas of breed pedigree and purity, commercial breeding, the breeding of dogs whose bodies are at increased risk of developing health problems, and a preference for canine rescue.[31] Those

28 Thompson, *Dog of the Decade*.

29 McHugh, *Dog*. As this suggests, the broad contrast between the high status and value of pedigree dogs and the vilified ordinary dog was not unchallenged. As Susan McHugh has shown, small pedigree dogs were often negatively associated with feminized, bourgeoise indulgence, in contrast to the masculinized figure of the tough street dog.

30 "AKC Canine Partners", *American Kennel Club*, https://www.akc.org/register/information/canine-partners/.

31 Bir et al., "Stated Preferences"; Bir et al., "Exploring Social Desirability". Some US states have adopted the rescue dog as the official state dog to promote the pro-rescue perspective. See for example "Delaware Has a New State Dog", *Delaware Public Media* 30 May 2023, https://www.delawarepublic.org/delaware-headlines/2023-05-30/delaware-has-a-new-state-dog.

who have mixed-breed dogs acquire them in a variety of ways, not just from shelters. Nevertheless, the significant proportion of dogs homed in this way suggests an openness to the possibility of choosing a mixed-breed dog and thus a significant shift away from prioritizing purity, pedigree and conventional breed embodiment.[32] But loving a "mutt" and loving a pedigree dog, or caring about dogs needing homes and being a fan of a pedigree breed are not necessarily opposed positions.

The question of loving the dog as an individual, and understanding them in terms of inherited characteristics that are understood to be shared by a breed or breed group, is, however, differently worked through when the loved dog is mixed (to different degrees and of a known or unknown mix) or pure bred. While it is the unknown nature of the mix that is made into a puzzle to be solved in these breed ascertainment tests, studies of the significance of breed to human relations with animals, especially farmed and companion animals, provides a useful foundation for exploring how breed mix is figured as valuable to interspecies or, more specifically, companion animal kinship. Since breeds are groups of animals produced by human control over reproduction, and interspecies kinship names the ongoing work of intersubjective, but always partial, connections with an individual animal across species difference, the category of breed and the concept and practice of interspecies kinship are seemingly at odds. However, it is not reproductive control that puts breed and interspecies kinship in tension, since interspecies kinship cannot be understood as somehow beyond the asymmetries of power in human–animal relations, including human reproductive control of animals in breeding.[33] Rather, it is the disjuncture between the individual and collective—or how breed as a category of difference intersects with partial intersubjective connections across species difference—which has been key to exploring the significance of breed to interspecies kinship.

32 A recent study reports that in the US this ranges from fifteen to thirty-two per cent, with higher income groups more likely to adopt from a shelter and with lower income groups more likely to acquire dogs through friends or family. Acquiring a dog through purchasing them ranges from fifteen per cent for lowest income groups to thirty-seven per cent for highest income groups. See Kremer and Neal, "Where Do They Come from".

33 Govindrajan, *Animal Intimacies*.

Farmed and companion animals embody the cultural and economic significance of breeds, but at least some farmed animals and most companion animals are known as individuals in human–nonhuman animal relations as well as through breed. Many companion animals have been bred to produce the potential for people to have rewarding relations with individual animals (through breed specific temperament, for example). Breed wealth, the value derived from harnessing the reproductive power of animals, thus includes this encounter value.[34] Recent research has begun to address the relation between inter-subjectivity in human and farm or companion animal kinships and the collective category of the breed into which the individual animal is subsumed. Breed is not found to be only a collective category (like herd, or flock) with objectifying and distancing effects that undermine the potential for mutual recognition and affective connection across difference in individual human–animal relations. Rather, people navigate the relation between their love of the breed (and how this might shape decisions about animal lives) and relationships with, and care for, particular members.[35]

This can be a knowing love, in which those who love their companion animals are aware of the affective and ethical complexity of valuing an animal both in terms of their breed and as an individual. For Donna Haraway, love of a breed requires an ethical engagement with a breed's origins; that is, the particular ways in which a dog breed's formation and function is entangled within historical geographies of modernity, and, in the case of her dog's breed, the violence and inequities of capitalist development and settler colonialism.[36] Similarly, Karin Bolender's creative practice works through her sense of shame and complicity in Western practices of producing and classifying animals through breed and denying their "embodied life stories". She does so by both critically engaging with the cultural appropriations and historical erasures in the making of the breed and honouring the unknowable interiority of the individual animal she

34 Franklin, *Dolly Mixtures*, 214; Ritvo, "Possessing Mother Nature".

35 See, for example: Bolender, "If Not for Her Spots"; Nash, "Valuing Difference"; Weaver, "'Becoming in Kind'".

36 Haraway, *When Species Meet*, 96–101.

loves and their shared stories.[37] These accounts of how people navigate their sometimes-knowingly conflicted attachment to breed and their care for individual pedigree animals are modes of engagement and kinship against which new forms of breed knowledge and evocations of kinship in the marketing of breed analysis tests can be considered. As I explore in what follows, customers of these tests are encouraged to think of breed as a valuable category through which their dogs can be known. Exploring how they do so means situating these tests within the wider ways in which breed frames how companion dogs are understood. Such ways of framing range from complex and critical historical geographies of breed origin to ideas of the behaviour associated with a breed. These breed epistemologies also need to be located within the wider interest in human origins and the science and cultures of human ancestry.

"Epistemophilia, the lusty search for knowledge of origins" that Haraway identified as "everywhere"[38] in the 1990s, including through the pursuit of human evolutionary self-knowledge via human genomics, also now aptly applies to companion animal genetic ancestry testing. Genomic studies of the origins, dispersal, evolution, and domestication of dogs closely followed at the heels of human studies, and new desires to know dog breed ancestry are now fostered in its applied science of mixed-breed analysis tests.[39] The sector's promise to provide a quantifiable mix of breeds as an answer to the question of "what breed or breed mix is your dog?" is made in the US context, in which knowledge of ethnic origins is deemed to be both a natural and necessary element of identity. The combination of this model of identity, the popularity of family history, the emergence of the world wide web, and the development of genomic research on human genetic diversity underpinned the highly profitable genetic genealogy sector. Its success over the past twenty-five years has deeply embedded genetic accounts of ancestry in American popular culture (and, to different degrees and with particular inflections, in other countries). This has prompted considerable debate among

37 Bolender, "If Not for Her Spots", 133.

38 Haraway, *Modest Witness*, 255.

39 Lindblad-Toh et al., "Genome Sequence"; Ostrander et al., "Demographic History".

ethicists, academics, and, to some extent, geneticists regarding the models of ethnicity, and origins that are offered to genetic ancestry test customers, and how the results are understood and used in relation to collective categories of identity and belonging.[40]

The political stakes of genetic breed analysis tests are less high. However, issues of the commodification of genealogical knowledge, the authority of science to supply and figure that knowledge, and people's agency in interpreting the results that have been explored in work on genetic genealogy also pertain to my engagement with dog breed analysis tests. Just as wider interests in ancestry provided a basis for genetic genealogy, the socio-cultural significance of breed turns the development of breed analysis tests into a business opportunity. Although, as I explore next, it is an opportunity that depends on presenting the value of mixed-breed knowledge in particular ways.

Applied Canine Genomics

Solving the mystery of mixedness depends on genomic knowledge of the pure. Mirroring the development of human genomics, the publication of the complete genomic sequence of the domestic dog in 2004 has been followed by research on dog genetic diversity.[41] This research is global in its reach but is applied in the commercial development of breed testing products in the US and other wealthy countries. Geneticists describe dogs as model biological organisms, in part because of modern dog breeding: they are the "earliest known domestic organisms"; the "only domesticated large carnivore"; the "most globally widespread and abundant carnivore"; and the "most morphologically diverse mammalian species", whose diversity is a "result of strong but evolutionarily recent artificial selective pressures on the basis of physical appearance, morphological functionality, and behaviour or temperament".[42] The existence of closed breeds

40 Abel and Tsosie, "Family History"; Leroux, "'We've Been Here'"; Reardon, "Democratic, Anti-Racist Genome?"; Roth and Ivemark, "Genetic Options".

41 Parker, "Genomic Analyses".

42 Bryce, "Dogs as Pets". See also Boyko, "Domestic Dog"; Karlsson and Lindblad-Toh, "Leader of the Pack".

makes it possible to investigate their genetic differences, ascertain the genetic basis to morphological variation, identify genetic variants associated with inherited disease, and use wider patterns of canine genetic diversity to study the origins, evolution, and domestication of the species, as well as the origins of individual breeds.[43] Canine genetics depends on the continued existence of genetically distinctive modern breeds in order to study the genetics of morphological variation. However, studying the global geographies of canine genetic diversity also depends on the continued genetic distinctiveness of village dogs (who are not subject to selective breeding). It thus also needs wider patterns of diversity not to be significantly altered by the increased interbreeding between imported modern dog breeds and village dogs before the evolutionary histories of village dogs can be studied.[44] The potential for reliable knowledge of canine genetic diversity to be disrupted by the genetic muddying effects of non-local dogs—usually recognized dog breeds—interbreeding with village, street, or feral dogs is a problem for canine genomics, even if the dynamic nature of dog populations is recognized, since it undermines the ability to treat them as sources of knowledge of canine evolutionary history. As in genomic studies of human diversity, mixing is a "problem".[45]

In contrast, however, the significant numbers of non-pedigree companion dogs in the wealthy minority dog world and the identification of genetic markers of breed difference turns mixedness into a business opportunity. This opportunity is enhanced by the existence of the genetic genealogy sector's highly successful business model. This model is one in which genomic knowledge is applied to produce genetic testing services, which customers order online.

43 Parker, "Genomic Analyses"; Rimbault and Ostrander, "So Many Doggone Traits"; Vilà and Leonard, "Origin of Dog Breed Diversity".

44 Boyko and Boyko, "Dog Conservation".

45 Human "mixing" makes it more difficult to treat contemporary populations as representatives of what are imagined as ancient and relatively stable patterns of genetic variation, thus the highly problematic figuring of indigenous groups as sources of genetic knowledge (TallBear, "Narratives of Race"). As genetically bounded populations, pedigree dog breeds are, in contrast, treated as ideal objects of analysis, and ideally free from the shadow of racial science.

Once the test kit is received by the customer, they gather and mail mouth cell samples back to the company, where the cells are analysed for their genetic material. The final report on the dog's genetic makeup is then reported back to the customer. These reports and company services are framed by a discourse of scientific authority and, in some cases, directly associated with named geneticists and genomic research projects.

The adoption of this model is most evident in the case of *Embark Veterinary, Inc*., one of the leading canine genetic testing services, based in Boston, Massachusetts. *Embark* is partnered with Cornell University College of Veterinary Medicine and was established in 2015 by brothers Ryan and Adam Boyko, a computer science graduate from the corporate sector and a biomedical scientist focused on dog genomics, respectively. Their commercial collaboration was initially presented as a "mission of discovery" that included research on the evolutionary origins of dogs in Central Asia, the history of dog populations around the world and the genetic basis of dog diseases. The framing of origins of the company in research adventures and commitments been reworked more recently to also suggest that customers' purchases are a form of citizen science since they provide data to help research on canine health: "Our founders, Ryan and Adam Boyko, spent years traveling the world and swabbing dogs in remote areas of Europe, Asia, and South America. But they knew there was more they could do to support all dogs. That's why they launched Embark: to enlist the help of dog lovers everywhere to turbo-charge this research."[46] *Embark* thus strongly links breed knowledge to dog welfare and overtly frames the business as ethical applied science.

This strategy of foregrounding scientific research and linking science to welfare strongly parallels one of the most well-known US-based human genomic research and genetic ancestry testing projects: the National Geographic's *Genographic Project* (2005–19). This project was led by geneticist Spenser Wells, who partnered with *FamilyTree DNA* to encourage people to buy genetic ancestry tests

46 "A Different Kind of Dog DNA Company", *Embark Veterinary Inc*., https://embarkvet.com/about/ (accessed 14 December 2025)

to generate income that would, partly at least, be channelled into support for Indigenous groups. *Embark*'s services are similarly presented through ideas of cutting-edge pure science, selfless heroic efforts to gather genetic samples worldwide, scientific advancement and biomedical value.[47] Furthermore, again echoing the close relation between human ancestry and dog genetic testing, accounts of *Embark's* founding in corporate news sources refer to Spencer Wells as a company co-founder, suggesting a direct involvement with what appears to be a clear effort to re-use key features of the successful *Genographic Project* model for the *Embark* startup. One report is also explicit about how the company began with the idea that "someone should make a 23andMe for dogs", referring here to one of the leading US-based genetic health and ancestry testing companies.[48] Like the other dog breed and health genetic testing companies, *Embark* reflects biotech and digital entrepreneurship in the lucrative pet care sector.

As with the genetic genealogy sector, developments in the science are quickly converted into additional or advanced services. For *Embark,* this includes broadening the dog populations knowable through their genetic identifiers. *Embark*'s list of breeds that can be identified by the tests, for example, include geographically identified village dogs. Similarly, *The Wisdom Panel* list includes street dogs. This reflects canine genomic research on local dogs of the majority world, in which their specific patterns of canine diversity are surveyed and made newly knowable and enclosed. They are not identified as breeds in the sense of pedigree and controlled breeding, but are breed-like in being treated as genetically distinct and named categories, which are listed alongside breeds.[49] These categories are incorporated into the breed testing services to extend the appeal of tests to those with dogs acquired as, or potentially

47 Nash, *Genetic Geographies*, 69–100; TallBear, "Narratives of Race".

48 Adams, "Startup, Embark". One news feature on *Embark* reports that "venture capitalists are increasingly financing startups looking to capture a portion of the [pet] market. Investors have poured $486 million into pet tech startups between 2012 and 2016" (O'Brien, "Genetic Testing for Dogs"). Some of the venture capital underpinning its development was from the founder of *23andMe*.

49 Boyko and Boyko, "Dog Conservation".

descended from, internationally rescued dogs. By making village or street dogs into genetic categories, they enhance the prospects of using foundational breeds categories *and* their mixing, to produce genetically derived mixed-breed knowledge as new form of breed wealth. As in human genetic genealogy, international research on genetic diversity feeds into product development, initially tailored to particular national minority dog world contexts and consumers, but with global ambition.

The parallels between human ancestry and canine breed genetic testing sectors also include the presentation of test results. Borrowing from genetic genealogy, the results of breed analysis tests that are sent to customers are presented in two main ways: as percentages of different breeds in a dog's ancestry and as a genealogical chart of what the dog's "family tree may have looked like", going back as far as eight great grandparents. One mode thus mirrors genetic ancestry tests, which offer estimated percentages of what is described as a person's ethnic and geographical background, based on the analysis of "ancestry informative markers" in their genome. The other deploys the form of the family tree from wider genealogical imaginations of human ancestry and animal pedigree.

Embark goes further in mirroring the model of genetic genealogy in two more ways. The first is in testing a dog's maternal mitochondrial and paternal Y-chromosome haplogroup, and offering customers the name, geographical origin, and spread of these two lineages in maps and in narrative form. The example of a test result on the *Embark* website explains that, "[t]hrough Bruce's Y-chromosome we can trace his father's ancestry back to where dogs and people first became friends. This map helps you visualize the routes that his ancestors took to your home".[50] The map for both maternal and paternal lineages are shaded red in western Europe to suggest the place of modern breed formation. One arrow arrives there from central Asia where wolf-to-dog evolution is thought to originate. Another goes from western Europe to other continents to indicate the spread of modern European breeds. The text describes the prevalence of the

50 "Bruce", *Embark*, https://my.embarkvet.com/dog/bruce82#paternal-haplotype.

broad haplogroup and the more specific haplotype geographically, and in which breeds it most commonly occurs. This presentation of results directly reproduces the visual and textual idiom of genetic genealogy and the way in which ancestry test results that would be the same for thousands of customers are presented as accounts of individual ancestral origins and dispersal.

Secondly, *Embark* also offers the promise of new relationships based on shared ancestry, which are enabled by systems in which customers can opt to "connect with relatives" who "match" through very broad lines of maternal and paternal ancestry. *Embark*'s "Canine/Doggy DNA Relative Finder" provides customers with a list of other dogs in their database that are ascertained to be related in some degree, based on a measure of genetic similarity. Harley, in one the examples from the website, is described as having twenty close relatives, through what is described as nine to eleven per cent genetic similarity, along with many extended family members. What is meant by "closeness" is explained in the case of Bailey and Maise, who share twenty per cent DNA and are described as "close family; the amount they share is similar to the amount you share with your aunts, uncles, grandparents and even half-siblings".[51] In both cases, the identification of relatives is entirely contingent on the database of previous test results. Customers are invited to act on those revelations of connection by getting in contact via a chat function and, if possible, "set up a play date" for their dogs. As in the genetic genealogy sector, rare discoveries of close relations—in this case, the reunion of sibling dogs—are used to amplify the appeal of establishing new social relations for these dogs and their owners by finding what, in reality, are very distantly related relatives. This is figured as a way of knowing one's dog more fully by getting to know their relatives and, thereby, becoming "closer to your dog than ever before". The suggestion is that caring for your dog can mean facilitating their contact with related dogs and, in doing so, honouring and respecting their own desire to feel connection. This implies an understanding of nonhuman animals as having social relations with their kind beyond human–companion animal kinship.

51 Padmabandu, "Discover Your Dog".

But this is a marketing ploy. Contrived kinship connections are given scientific credibility and presented as the basis for forms of social networking that facilitate kinship between dogs, which enhance human understanding of their dogs and deepen kinship between them. The conventionally positive associations of kinship (connection, closeness, care), including popular multispecies versions of "furry families", help sell products and services.[52] Ideas of human–dog kinship, in particular, are central to the marketing of breed ascertainment tests. Knowledge of the breeds in a mixed-breed dog's ancestry is figured as a means for owners to know, care about, and bond more deeply with their dog. The *Orivet* test providers, for example, "aim to encourage the development of a deep, genuine and lasting bond between pets and their owners".[53] Breed as a category, not only of morphological but also behavioural difference, is key to this.

Within US dog cultures, it is a widely held belief that responsible dog care means taking into account inherited specific breed characteristics when choosing a breed best suited to the location, space, and time constraints and composition of the household. Being attentive to such questions is likewise believed to ensure the success of the human–companion animal relationship and the wellbeing of the dog. Asking such questions, though, means treating them not just as an individual but as a member of a breed who shares the inherited temperament and abilities, as well as morphology, of that breed. Kennel clubs, breed clubs, and breed guides all describe breed-typical behaviour as well as physiology, often relating to the origin of the breed as guarding, herding, hunting, or retrieving dogs.

52 This is most explicit in the name and description of *Kinship*, launched in 2019 as a business development division of the huge international pet care and feeding company Mars Petcare, that includes the Wisdom Panel test, and which is a segment of the mega corporation *Mars, Inc*. Human and interspecies kinship frame its prospecting for return on its venture capital: "Kinship is a Family. A family of interconnected brands. Like most families, we have different interests and expertise. But we all come together with a common purpose and love of pets—because they're our kin too." There is no mention here of the ethical challenge of addressing interspecies kinship in terms of human power and violence as well as connection and care across difference. Instead, kinship is appropriated to support corporate profiteering. See "About Us", Kinship, https://web.archive.org/web/20240529051935/https://kinship.co/about/ (Accessed May 2024).

53 "Why Orivet", *Orivet Genetic Pet Care*, https://www.orivet.com/why-orivet.

The injunction to choose a dog whose needs can be met extends to the acquisition of mixed-breed dogs, but without the apparent surety of conventional breed behaviour descriptions.

Breed ascertainment test companies deploy these ideas of breed difference and appropriate care to effectively construct an ethical imperative to know the mix of breeds in a non-pedigree dog, by suggesting that knowing this is a way of understanding their behaviour, caring for them appropriately, and thereby deepening kinship with them. Pure breeds with their conventional behavioural attributes are thus foundational categories in the quantification of mixed-breed ancestries and in the interpretative tools provided to customers. The *Wisdom Panel* and *Embark* test websites, for example, provide descriptions of breed characteristics, including temperament and guidance on care and training, to help customers make sense of the results.

Yet the value of the tests is not straightforward. The company websites feature testimonies from those who describe how they now better understand their dogs and how that knowledge has helped them bond with their dog. The results have most relevance to owners of mixed-breed dogs with a recent ancestry from pedigree dogs, such as dogs with pedigree parents. But, this pedigree parentage is likely to already be evident in their body shape, and owners commonly refer to evidence of this mix—and what it means in their accounts of their dog—as their dog "having some Collie in them", for example. The test results cannot help much in interpreting the needs and behaviour of more mixed dogs. Effectively, the more complex the mix, the less informative are the results. This is because the shuffling of genetic material in reproduction means that what is inherited varies between dogs from any one pairing. Furthermore, the possibilities of inheriting characteristics from any one pure breed dog in a dog's very mixed ancestry are increasingly slim with increased mixedness. This unpredictable mixedness thus makes simple interpretations of a dog's genetic ancestry increasingly difficult. However, this qualification about the effects on increasing mixedness still upholds the idea of distinctive breed behaviours as a foundational truth. This, as I go on to explore, is not the case in canine behavioural science, nor among dog people.

Heredity in Question

The degree to which breed relates to a dog's characteristics and abilities has been the subject of recent canine behavioural research, which has examined, complicated, challenged, or qualified ideas of breed-typical behaviours. For example, two papers published in 2022 focused on the degree to which variations in dog behaviour and abilities relate to breed differences. Both share the broad position of the field that an individual dog's behaviour has to be understood as the outcome of the combined effects of inheritance and environment, but differ in their arguments about breed-distinctive behavioural traits. The first paper by Kathleen Morrill and colleagues found that, while heredity in general explains behavioural traits—but to different degrees depending on the trait—there are no behaviours exclusive to any breed, and breed uniqueness is only responsible for some behavioural variation. As they explain, though most behavioural traits are partly inherited, "behavior only subtly differentiates breeds. Breed offers little predictive value for individuals, explaining just 9% of variation in behavior".[54] The study suggests that some breed-differentiated traits are more heritable than others, making it possible to argue that some pure breed ancestry in mixed-breed dogs could predict some behaviours (such as biddability in dogs with some Border Collie ancestry, for example). For other traits, their research suggests that "breed is almost uninformative" as a predictor of behaviour. Their conclusion is that "behavioral factors show high variability within breeds, suggesting that although breed may affect the likelihood of a particular behavior to occur, breed alone is not, contrary to popular belief, informative enough to predict an individual's disposition".[55] This includes patterns of dog attachment to humans, which have not been found to vary according to breed. These findings confound popular ideas of particularly loyal or loving breeds.

The second paper offered a contrasting conclusion. Saara Junttila and colleagues argue that their observations of dog responses to

54 Morrill et al., "Ancestry-Inclusive Dog Genomics", 1.

55 Morrill et al., "Ancestry-Inclusive Dog Genomics", 5.

tasks suggest that most of the behavioural and socio-cognitive abilities they examined differed significantly between breeds, although this pattern does not extend to non-social cognitive traits, such as memory and spatial problem solving. They conclude that there are significant breed differences for various behavioural and cognitive traits in dogs; however, the findings are qualified by their acknowledgement that the study (like others) was "not able to control for the possible effects of training, environment, life experiences, or background of the dogs", even though "previous studies suggest that environmental effects are unlikely to be the only explanation for breed differences".[56]

These studies—one challenging breed-typical behaviours and the other identifying behavioural differences between breeds—demonstrate the ongoing debate on breed differences within canine behavioural research. As those involved argue, the results are often difficult to compare due to some studies examining breed group differences rather than breed differences, the use of different methods to measure behavioural traits, and the focus on different characteristics (e.g. problem solving, trainability, or boldness). This is further complicated by how studies that look at breed group differences may use very similar, but not identical, breed groups.[57] Studies thus produce varied accounts of the degree to which distinctive traits can be identified for specific breeds and breed groups. Recent

56 Junttila et al., "Breed Differences".

57 In some research projects, the behaviour of an individual dog included in a study could be studied to address *breed specific* behaviour, but in other projects the same dog's behaviour could studied to address *breed group* behaviour. In the first case, they represent the breed, while in the second, they represent the breed group according to where they fit within the grouping adopted in the study. As Mehrkam and Wynne point out, many studies use the breed group classifications of national or international kennel clubs, which group dogs according to the historic function of the breed, such as herding, hunting, or toy dogs. However, breed group classifications vary. The American Kennell Club identifies seven breed groups, while the Fédération Cynologique Internationale identifies ten breed groups due to finer differentiations of the herding categories, giving dachshunds their own group and including a Spitz and primitive type group. This is complicated further by some studies grouping breeds according to genetic similarity into four main clusters: "Asian/African breeds, mastiff-type dogs, herding dogs and sighthounds, and modern hunting dogs" (Mehrkam and Wynne, *Behavioural Differences*, 14).

research suggests that the question of how much breed shapes behaviour cannot be answered simply without taking seriously the different degrees of heritability of different characteristics; the variation in how much and which behavioural differences reflect breed categories; and the problems of definitions of characteristics, such as intelligence, which take different forms and thus differ qualitatively rather than quantitatively.[58] In individual dogs, behaviour has also been found to correlate most with the role of recent preceding generations (as working, show, or companion animals), rather than with traits associated with a single breed standard.[59] Breed ascertainment tests thus frame their work with the authority of canine genetics to identify breed ancestry, but necessarily elide the complexities and contested nature of canine behavioural science, in which the existence and significance of inherited breed and breed group behavioural characteristics over environment is an ongoing debate.

By titling their paper "Ancestry-Inclusive Dog Genomics Challenges Popular Breed Stereotypes" Morrill and her co-authors suggest that they offer a more definitive answer to the question of how much breed can predict a dog's character. This attracted widespread media attention and discussion among dog owners, trainers, veterinarians, and welfare advocates working through the relative significance of breed, individuality, inheritance, social environment, and training in understanding the character and needs of individual dogs.[60] Animal behaviourist Monique Udell welcomed the paper as a timely contribution to a growing empirical emphasis on dog individuality in canine

58 Hart and Hart, "Breed and Gender Differences"; Mehrkam and Wynne, "Behavioral Differences"; Van den Berg, "Genetics of Dog Behaviour"; Wells, "Factors Influencing the Expression".

59 Svartberg, "Breed-Typical Behavior".

60 See, for example, Corinne Purtill. "What a Dog's Breed Can, and Can't, Tell You About Its Behavior." *Los Angeles Times*, 28 April 2022. https://www.latimes.com/science/story/2022-04-28/genetic-study-says-stereotypes-about-dog-breeds-are-wrong; Becky Sullivan. "Your Dog Is a Good Boy, but That's Not Necessarily Because of Its Breed", *NPR*, 28 April 2022, https://www.npr.org/2022/04/28/1095390872/dog-breeds-behavior-study. The study was also discussed on *Reddit* forums about dogs and dog training, as well as general science, receiving 2,500 comments. See rjmsci, "Dog Breed Is Not an Accurate Way to Predict Behavior", *Reddit*, 28 April 2022, https://www.reddit.com/r/science/comments/ue14lz/dog_breed_is_not_an_accurate_way_to_predict/.

science that "may force those who study, work, and live with dogs to take a step back from breed-based heuristics that we have come to rely on."[61] As she argues, this does not mean overlooking the study's findings that some behaviours are highly heritable and that breed may be a strong predictor of behaviour for breeds that originated as working dogs—herding, hunting or guarding—but not for others. Its value for her lies in its contribution to the growing recognition of the problems of treating breed as a predictor of behaviour and temperament. This includes the poor placement of individual dogs as companion or assistance dogs; the unwarranted negative stereotypes of some breeds and problems of rehoming them; discrimination against the owners of "problem" breeds in access to housing and insurance, for example; the risk of overlooking the problem behaviours of individual dogs of other breeds, and responding to fatalities and injuries by dogs by banning "dangerous dog breeds", rather than addressing problematic training and care.

Claims that knowing the breed ancestry of a mixed-breed dog is a way of knowing and caring for them depend on treating breed characteristics as a stable reference point. They thus conflict with recent moves to challenge "breed-based heuristics". This includes the work of canine ethnologists Lisa Gunter and Clive Wynne who, with their collaborator Rebecca Barber, used the Wisdom Panel Canine DNA Tests from Mars Veterinary, which funded the research, to compare the results of the genetic breed ancestry tests of shelter dogs with the breed identifications made by staff at the shelters. They found the degree of mixing in most of the dogs suggests that descriptions of shelter dogs as "single breed with mixed or with primary and secondary breeds listed" are inaccurate in most cases.[62] Yet, the results were not used to recommend the greater use of genetic testing for shelter dogs. Instead, they suggested not using breed labels to describe them at all, not only because of the problems of rehoming dogs that were identified as pit bull dogs, but also due to reductive understandings of dog behaviour based on breed characteristics

61 Udell, "Challenging Stereotypes", 442.

62 Gunter et al., "Canine Identity Crisis", 11.

more widely.[63] As Wynne argues, "the genetics of behavior is so complex that a dog who is a cross of two breeds might not behave much like the typical members of either of its parents' families". For Gunter, "what really matters is a dog's behavior and how it might fit into an adoptive family […]. Shelter dogs are interesting and complex genetically […]. They really are individuals, and labelling them with a single breed can minimize their uniqueness".[64] Shelters, they argue, should replace breed mix descriptors with behavioural assessments for potential rehomers.

Such calls to action are having some impact. For example, they informed the decision of the Arizona Animal Welfare League in Phoenix to stop publicizing breed information on their website and on kennel cards.[65] Michael Morefield, the shelter's director of marketing and communications, explained this decision:

> Everything about the life experience of a dog—where he was before coming to the shelter or any medical issues he might have—is what makes him who he is, not who his grandparents might have been […] When you adopt a dog, you are not adopting a bully, a German Shepherd or St. Bernard, you are adopting Jerry or Mo. When you love a dog, you don't love a German Shepherd. You love Jerry.[66]

This emphasis on the individuality of a dog, and the significance of experience in shaping behaviour, is a notable counterpoint to the emphasis on breed-typical temperaments in approaches to responsible dog acquisition and in the marketing of genetic breed analysis tests as practices of care and kinship.

But this does not mean that breed does not matter. Breed is a form of knowledge that continues to shape ideas of dog behaviour

63 Similarly, veterinarians argue for the use of a single term to describe all non-pedigree dogs to avoid inaccurate visual assessment of breed background and to avoid the term being taken to mean a "dangerous" breed mix if only applied to dogs who appear to have these breeds in their background. See Simpson et al., "Rethinking Dog Breed Identification".

64 Arizona State University News Release, "More than a Label".

65 Gunter, Barber and Wynne. "What's in a Name?".

66 Arizona State University News Release, "More than a Label".

and care, albeit in changing and contested ways; owner perspectives, commercial claims, and canine behavioural science are rarely smoothly and securely aligned and are often at odds. This is especially the case given different arguments within canine behavioural studies about the existence and significance of breed behaviours. Dog people, those who live with domestic dogs in the wealthy minority dog world, work through the different ways a dog can be known and what can ever be knowable, whether they have pure bred or mixed-breed dogs. Since breeds are not genetically homogeneous, owners work out the different weighting they ascribe to inherited genetic uniqueness, parentage, and breed, on the one hand, and experience and training on the other, in shaping the character of an individual dog and guiding their care. These deliberations intersect with wider public debates about the relative significance of these factors, especially in relation to dog breeds deemed to be "dangerous". The existence of several popular online dog forums and the intensity and volume of the discussion of these questions on them reflect the significance of these issues in public debate, between dog owners, and within personal deliberations.[67] The complex findings of canine behaviour science, including new genomic studies that reach the wider public via condensed media reporting, enter this field of off- and online debate on the subject of "deed or breed". This is a debate about inherited specific breed characteristics and the influence of experience, the significance of broad breed character (especially for dogs derived from working breeds like those with hunting, guarding or herding histories) and the individuality of all dogs of "pure" or mixed breed status. Added to this debate is the significance of the direct inheritance of character from a dog's parents. For many owners of a mixed-breed dog, especially those who home rescue or stray dogs, who have no certain knowledge of the breeds of dogs in its ancestry, accessing mixed-breed knowledge provides a resource for considering what has shaped their dogs' character. However, it is not used as the singular or determining factor in shaping the character of their dog, guiding their

67 Non-breed specific forums include *DogForum* (https://www.dogforum.com/) and the subreddit r/DOG (https://www.reddit.com/r/DOG/), both of which have several sub-forums relating to training, feeding, or specific breeds.

care, or affecting their relationship, which is thus more aligned with the shift away from "breed-based heuristics" in canine behavioural science than with the companies' claims.

In fact, contradicting the messaging from companies that provide breed genetic testing, for many dog owners, breed knowledge is often not seen as key to connection and kinship. Media features in which journalists report on their experience of receiving their dogs' test results often end with comments that the results had no effect on how they feel about their dog.[68] Such views are paralleled in recent studies of customer responses which suggest that, for most people, breed results had no impact on care or their feeling towards their dog. Nikki Bennett and Peter Gray have found that most customers strongly agreed that "the test allowed them to learn about their dog's background because they had limited information about their dog (73.0%), [and] to satisfy their curiosity about their dog's breed composition (72.3%)".[69] This informs the largely positive customer reviews of the tests.[70] While some altered their dog's training (20.9 per cent) and care (9.5 per cent), most participants (67.6 per cent) reported that they did "nothing else" with the results. Only two per cent reported that they actually used the results for insights into personality or behaviour.[71] Focusing more specifically on human–canine bonds, Bennett et al. report that customers say that the tests allow them to learn more about their dogs, "but the information alone does not influence how they feel about their dogs".[72] Only twenty-three per cent strongly agreed that the results of the tests made them feel closer to their dogs, 45.5 per cent strongly disagreed, and 28.9 per cent neither agreed nor disagreed that they felt different towards them.[73] Since their initial research suggests that the impact of the tests on care and connection is limited, Bennett

68 See, for example: Nicolaou, "I Discovered"; "As Dog DNA Testing Takes Off, Experts Urge Caution." *CBS News*, 11 February 2019. https://www.cbsnews.com/news/dog-dna-testing-generates-debate-experts-urge-caution/

69 Bennett and Gray, "Study Evaluating Consumer Motivations", 7.

70 Bennett et al., "Exploratory Content Analysis".

71 Bennett and Gray, "Study Evaluating Consumer Motivations", 10–11.

72 Bennett et al., "Dog Guardians", 8.

73 Bennett et al., "Dog Guardians", 5.

et al. propose further research on other ways the results may have value. They speculate about whether customers would choose to convey versions of the breed results that relate to the social identity they may wish to project, in ways that mirror people's selective ancestral identification in response to the results of human genetic ancestry tests.[74] While some people may wish to avoid, or indeed claim an association with, "dangerous" breeds via the results, my engagement with both suggests that the relation between genetic breed analysis and genetic genealogy is broader. It reflects not so much the cultural connotations of specific breeds for their owners, but the way in which dogs in all their variety stand for the human ability to create animal bodies of particular forms through breeding and how that cultural creation lies behind that frequently asked question: "what breed is your dog?"

The morphological diversity of dogs and the relatively low cost of their breeding make it the most accessible way in which people outside the worlds of livestock, equine, and conservation breeding can partake in the practice of cultivating nature with quick results. But engaging with breeding's reproductive experiment is not confined to breeders. The modern Western conventional organization of that diversity into various breeds also means that the people who are interested in dogs, but not likely to ever breed them, can take part in the guessing game of working out what breeds may be in the parentage of a mixed-breed dog. This happens both during encounters with dogs out and about and online. Many owners of mixed-breed dogs post photos of their dogs on dog-related online forums for other dog enthusiasts to guess the breed mix and then be told the answer, often with reference to DNA breed test results. Others who do not know anything of the breed background seek out possible answers from other dog owners.[75] This prompts some to question why this matters and for others to suggest that guessing is a fun game

74 Bennett and Gray, "Study Evaluating Consumer Motivations", 12.

75 At the time of writing, the subreddit "ID my dog", which was founded in 2014 and invites people to "[p]ost pictures of your dog, and we'll try to determine its breed", has ninety-three thousand members (https://www.reddit.com/r/IDmydog/). The subreddit "Doggy DNA", which invites discussion of the tests and the posting of test results, was founded in 2013 and has eighty-eight thousand members (https://www.reddit.com/r/DoggyDNA/).

of "breed bingo", all of which suggests that curiosity is the key driver of this desire.[76] Breed creates this compelling puzzle of mixedness. Mixed-breed dogs, as well as new "designer breeds", embody the vicarious pleasures of taking two different animals and creating a mix that can be appraised for the evidence of breed inheritance in their size, shape, coat, and character. The puzzle of mixture is about finding answers to people's guesses—what mix has produced this?—curiosity about less familiar shapes and sorts of dogs—is it an unfamiliar breed, a new "designer" cross, or another sort of mix?—and, for dogs judged to be particularly appealing in appearance, interest in potentially acquiring a similar dog from a similar mix.

Curiosity about breed is often joined to curiosity about origin. An extended answer to the question of where a companion minority world dog comes from—whether mixed or pedigree—could include multiple geographies of breed and origin: the environments of human and dog co-evolution that shaped the geography of canine diversity; the places in which selected dogs were formally enclosed in as modern European breeds; the importation of dogs from other places in this process; their colonial-modern geographies of migration with humans; new locations of breed refinement or reformulation; contemporary international economies of dog trade and rescue; and the place from where a companion dog was brought home. The origin stories of dog culture are usually more immediate. They are not so much the breed origin stories of settler-colonial power and oppression that Haraway or Bolender reckon with, but everyday accounts of where the dog came from. Stories of acquisition from breeders of different kinds, friends, family, shelters, or international rescue organizations are part of how dogs are known by owners and narrated to others, proffered or prompted by the "where did you get your dog?" as well as the "what sort is it?" questions in trail and dog park conversations. Everyday accounts of where a dog came from do not necessarily grapple with questions of how an individual's choice of dog can implicate them in the wider cultures

76 IndianRedditor88, "Why Do People Ask What Breed Their Dog Is?" *Reddit*, 24 September 2023, https://www.reddit.com/r/DOG/comments/16qq2c9/why_do_people_ask_what_breed_their_dog_is/.

and economies of breeding that are often entangled with historical and contemporary injustice; entanglements that Harraway and Bolender argue need to be acknowledged. Yet they are often inflected with an awareness that pedigree breeding and buying from a commercial breeder are contentious issues. In answering the question of "where did you get your dog?", owners are often conscious of debates regarding the ethics of acquisition. Their dog's origin story can signal the owner's perspective on adoption from shelters or purchase from breeders and create dissonance or affinity in these exchanges. The prominence of the pro-rescue perspective in the US context, for example, means that, in some encounters, those with dogs that were not adopted from shelters have to negotiate the risks of being subject to "non-rescue stigma" from those who have homed shelter dogs for ethical reasons.[77]

In the dog cultures of the minority dog world, all dogs are also understood to have origin stories — stories of acquisition, parentage, place of origin of themselves or the breed — known, or partly known, and potentially extended via breed test results. Breed ancestry can offer more substance to origin stories that are only partially known. In the US context, dogs adopted from shelters are often described as "orphans" who are homed without any or much of a story.[78] A mixed-breed dog also has a story of mixing to be deciphered, guessed, asked about, and tested. As writer Kelly Conaboy puts it: "With a rescue, everything about what makes up their body is a mystery. It's nice to imagine the results as a little history of Peter coming to be and who his parents might've been. Any solid knowledge helps when you're so in love with these little creatures who are mysteries".[79] In this sense, the results do not change the relationship, but reflect it. Their value is also relational in a wider social sense. Explanations of the breed mix from the tests provide at least some material for origin storytelling. As one participant in an online discussion

77 Romo et al., "Examination of Communicative Negotiation".

78 Some dog adoption centres use this term in their names, such as Pet Orphans of Southern California (https://petorphans.org/) and Orphans of the Storm Animal Shelter (https://orphansofthestorm.org/).

79 Quoted in Nicolaou, "I Discovered".

of why those who have mixed-breed dogs want to know the mix explained: "Every time we go anywhere I am asked 'What kind of dog is he?' I don't want to look dumb and have to shrug my shoulders and say 'I don't know.' Lol. […]. Now I have an answer besides 'the good kind'".[80] Having an answer via the tests makes for a more satisfying, and perhaps convincing, exchange, or it can counter the claims of intrusive "experts". Conaboy reports on doing a breed analysis test in response to the rude certainty of one "expert" in the park on the breed of her mixed rescue dog.[81] Having been informed by a vet that breed tests have no current practical value, she concludes that she will use the information on her dog's breed mix "against rude men who think they know more about my dog than I do at the dog park".[82] Another report on using the tests concluded: "Do the results change how I feel about my dogs? Not a single bit. But at least now when someone asks me what kind of dog I have, I'll be able to answer the question".[83]

Conclusion

The displacement of pedigree and purity as the dominant framing of a dog's value in the US and other minority dog world countries does not mean that breed no longer frames understandings of dogs. The modern making of breeds as enclosed categories of morphological and genetic difference continues to shape understandings of subspecies difference, despite the large numbers of dogs that are not pure and pedigreed in the minority dog world. People appraise dogs at large and make sense of their own at least partly through ideas of breed difference. As my engagement with genetic breed analysis suggests, reflections on the significance of inherited characteristics that relate to breed are not limited to those

80 Comment by Rebeccaissoawesome on Reddit thread "Why Do People Ask What Breed Their Dog Is?" 24 September 2023, https://www.reddit.com/r/DOG/comments/16qq2c9/comment/k1zgs8j/

81 Kelly Conaboy. "Stop Mansplaining My Dog to Me: Decoding My Pup's DNA." *The Guardian*, 24 April 2018. https://www.theguardian.com/lifeandstyle/2018/apr/24/dog-breed-dna-genome-genetic-testing.

82 Conaboy, *Particulars of Peter*, 27.

83 Castillo, "I ran a DNA Test".

whose animals are pedigree breeds. The development of genetic breed analysis tests, and the appeal of knowing breed ancestry for those with mixed-breed dogs, testifies to the way in which breed remains a potent imaginary of difference. These technologies and forms of knowledge play upon an imagination of canine difference in which modern breeds remain fundamental categories through which dogs are known. However, while many are committed to the continuation of traditional pedigree dog breeds, wider interests in breeds among dog people are no longer dominated by the ideal of breed purity, and disdain for the mutt. Instead, pedigree breeds are the materials for producing new combinations and the basis of the puzzle of the mixed-breed.

This makes breed mixture a resource to be mined by breed analysis companies. Commodifying breed, not in terms of purity but rather in its absence, via genetic accounts of admixture thus works to produce a new form of breed wealth. This is a new way to derive profit from breed, not through the genetic capital of enclosed breeds of farmed animals from whose bodies profit is derived and whose reproductive potential is commodified, nor the value of pedigree companion animals, but from the puzzle of mixture. Capitalizing on mixture depends on the persistence of imaginaries of breed difference (including their extension to new genetically codified village and street dogs formerly outside the category of breed), since their claims depend on asserting the value of knowing the nature of the mix as a way of knowing a dog.

In making this a puzzle worth solving, breed analysis companies take the tenet of breed differences in behaviour—and thus needs—as a foundation for their claims about the value of these tests. This is despite the complexities and contradictions of studies of breed and breed group differences, despite challenges to "breed-based heuristics" in relation to knowing and homing dogs, and despite the ways owners of dogs—mixed or not—work though ideas of type and individuality, inheritance, and experience in understanding them. For owners of mixed-breed dogs, this involves speculation about the breeds in the mix from clues of body shape and behaviour,

interpretation of their significance, and engaging with their dogs as individuals who are known through the everyday and mutual work of learning how to get on together.

By deploying ideas of ethical care and kinship, breed analysis companies encourage people to pay for a scientific answer rather than be satisfied with wondering about or simply guessing their dog's breed makeup. They sell a kinship with positive associations of care, connection, and fellow feeling, but one that is shorn of the challenges and complexities of interspecies kinship in practice, in which getting along together is inescapably inflected by human power over companion animal kin.[84] Buying the tests is presented as an act of care in itself since breed ancestry knowledge is presented as a way of tailoring care to one's dog, thus deepening human–dog connection, even in cases of very mixed ancestries where the implications for the dog's character are impossible to know. The uncertainties of breed distinction are elided in their claims regarding breed knowledge, care, and kinship.

Yet, among customers of such tests, breed knowledge does not matter in the ways proffered by genetic breed test companies. The largely inconsequential nature of the results for dog care and human–companion dog relations suggests that being able to describe the mix of their dog does matter to customers, but not as the basis of kinship. It matters because of the way breed continues to frame how dogs are seen, so that, for owners and those who encounter them, the mixed dog cannot *not* be a puzzle to be guessed and potentially genetically solved. Socio-cultural norms in the US of knowing oneself and narrating ethnic ancestral origins to others, often through genetic ancestry, are thus paralleled by a sense that dogs of all kinds can also be known through breed. Enquiries about breed type and origin are no longer guaranteed to be only curious and detached from contentious issues of the ethics of breeding and acquisition (even if less likely to shaped by critical engagements with "love of a breed" and a bred companion

84 Haraway, *When Species Meet*; Govindrajan, *Animal Intimacies.*

animal).[85] Yet curiosity about breed continues to drive these enquiries. The questions asked by other people in parks, on streets, and on trails reflect the persistence of modern breed imaginaries of fixing and mixing: the ideal of named and contained categories of dog diversity and the fascination with the outcome of crossing. Their promise and appeal testify to the hold breed has on human understandings of dogs, in the minority dog world especially, in terms of their genealogical relationship to categories of codified difference, even if less definitively as guides to character and behaviour. As the accounts of using the tests to help create a "backstory" for mixed-breed rescue dogs suggest, breed is not so much a determining category for knowing a dog's character or for producing companion animal kinship. Rather, the named breeds and their proportions in a genetic breed test report are increasingly a strand in the origin stories of breed mix and acquisition, through which dogs are known by owners and narrated to others. The capacity of genetic breed ascertainment tests to make sense and make money reflects a specific historical moment and geographical context in which dogs, as well as people, are known through ancestry and origin stories.

85 Bolender, "If Not for Her Spots"; Haraway, *When Species Meet*.

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