Article

Dimensional and Hierarchical Assessment of American Kennel Club Breeds and Behavioral Trait Descriptions

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Abstract: The AKC functions as the largest and most influential dog breed registry and breed standard information source in the United States. AKC breed standards describe the breed's overall appearance and behavior. Despite their popularity, the AKC behavioral descriptions and the traits used to quantify them have largely remained unexplored. In this study, we used eleven behavioral breed standard traits for 286 breeds collected for the official AKC source. Dog size and appearance were also evaluated. We employed pairwise correlation and factor analysis to define behavioral trait constructs and hierarchical clustering methods to evaluate the similarity of breed profiles. These methods revealed that although AKC data exhibit various individual correlations concurrent with known canine behavior, many breeds present behavioral trait constructs that do not align with the narratives presented in their standard and may be lacking crucial factors in dog behavior, as suggested by breed group clustering. Our dimensional analysis revealed three constructs, which we labeled as "Social Engagement", "Pet Demands", and "Vigilance", that are very important and relevant to pet ownership. These results emphasize the importance of standardized observations when quantifying behavior and provide an overarching context regarding the strengths and weaknesses of these descriptions, allowing readers to better understand and predict their pet's behavior.

Keywords: behavior; breed standards; clustering; American Kennel Club

1. Introduction

Humans have coexisted with dogs for thousands of years and developed a mutually beneficial relationship [1]. Although dogs have been raised to complete a variety of tasks to support humans, the most common dog occupation is that of a pet companion. In 2022, the American Veterinary Medical Association reported that approximately 44% of U.S. households own a dog, which is a 6% increase from their 2016 report [2]. The motivations for pet owners for owning a dog and for selecting a specific dog can be complicated; however, appearance and temperament are at the top of the list [3–6].

Dogs come in many shapes and sizes but also with large variations in temperament and behavior. A key concept in modern dog selection are dog breeds, which help to standardize such variability. In this modern context, breed dog breed standards are often used as predictors of a dog's mental [7] and physical traits [8]. A dog having its pedigree registered with a breed's kennel club can be a tool for prospective owners, as it is intended to denote a pet coming from a controlled gene pool and, thus, having less variability in physical traits and expected temperaments. It is for this reason that breeders can sell puppies with a registered pedigree at a higher cost than those without a registered pedigree—not to mention the prestige that many owners find in their pet's exclusivity when viewed as a commodity [3]. Designer mixed-breed dogs such as "labradoodles" and "shih-poos" often fetch a much higher price despite the lack of pedigree, but their sales are largely unregulated and go unreported [9].

Although there are many kennel clubs around the world, in the United States, the most influential is the American Kennel Club (AKC) breed registry, which functions as a "kennel club of kennel clubs", so to speak. The AKC registers over 700,000 dogs and 300,000 litters yearly [10], and even though the AKC does not set breed standards—which is conducted by its constituent kennel clubs–, the organization has vested interest in advocating for and characterizing the breeds they represent. In addition to appearance breed standards, the AKC also provides behavioral descriptions of each recognized breed and categorizes them into various groups based on what each breed was traditionally selected for. These behavioral breed descriptions have a strong impact on people's perceptions and expectations [11] and can be used to prime future pet owners in their perceptions and decisions [12]. Furthermore, behavioral selection in dogs is also relevant from a broad epidemiological perspective of dog bites because specific traits can be suggestive of aggressive dog behavior, which is a significant public health concern [13].

Because breed standards are so important for pet owners when selecting their pet dog [5] and the AKC is the most popular source of breed standards and breed description information [4], we question, from a behavioral point of view, what these behavioral standards are actually representing. Thus, the objective of this paper is to explore the behaviors quantified in the AKC breed descriptions. Specifically, we aim to define what underlying trends these behavioral traits are describing and to compare how those traits are present among AKC dog breeds in relation to each other. We expect this work to be useful for understanding how dog breeds behavioral diversity is being popularly portrayed with the expectation of being a source of reference for veterinary professionals, dog breeders, and future pet owners.

2. Materials and Methods

2.1. Data Source and Trait Coding

Dog breed standards and breed description data were sourced from the official American Kennel Club (AKC) public website www.akc.org (10 July 2024), where breed profiles are presented for each breed recognized by the club alongside the official breed standard proposed by the breed's kennel club. Data were collected for each breed from the profile web page breed characteristics description panel that contains breed size standards (height, weight, lifespan), appearance (coat type and maintenance ratings), and behavioral traits (11 traits grouped in three sets family life, social, and personality traits).

For size standards, dog weights and heights were recorded, as presented on the website in pounds and inches. Life expectancy was recorded in years. For these traits, an average was calculated for the max and min across the two sexes. An overall average was also calculated. For appearance traits, coat type was coded as binary (present/not present), while maintenance traits were recorded as presented in a 5-point Likert scale. The maintenance trait group included three traits: "Shedding Level", rated from "No Shedding" to "Hair Everywhere"; "Coat Grooming Frequency", rated from "Monthly" to "Daily"; and "Drooling Level", rated from "Less Likely to Drool" to "Always Have a Towel".

All behavioral traits are presented in a 5-point Likert scale. Three traits are presented in the family life category: "Affectionate with Family", rated from "Independent" to "Lovey-Dovey"; "Good with Young Children", rated from "Not recommended" to "Good with Children"; and "Good with Other Dogs", rated from "Not Recommended" to "Good with Other Dogs". For the social category, four traits are presented: "Openness to Strangers", rated from "Reserved" to "Everyone Is My Best Friend"; "Playfulness Level", rated from "Only When You Want To Play" to "Non-Stop"; "Watchdog/Protective Nature" rated from "What Is Mine Is Yours" to "Vigilant"; and "Adaptability Level", rated from "Lives For Routine" to "Highly Adaptable". The personality category presents four traits: "Trainability Level", rated from "Self-Willed" to "Eager to please"; "Energy Level", rated from "Couch Potato" to "High Energy"; "Barking Level", rated from "Only To Alert" to "Very Vocal"; and "Mental Stimulation Needs", rated from "Happy to Lounge" to "Needs a Job or Activity".

Breed groups were also recorded as presented by the AKC. Under the AKC, there are 8 groups [14]. Seven represent defined roles based on the purpose they were developed for Herding, Hound, Non-Sporting, Sporting, Terrier, Toy, and Working groups. Additionally, there is one other group labeled as "Miscellaneous", which is for breeds not currently in a specific group. The Miscellaneous group also has an additional subgroup called the AKC Foundation Stock Service or FSS, which is a record-keeping program for rare dog breeds that have not reached full recognition by the AKC [15]. All data used in this study are available as Supplementary Materials.

2.2. Statistical Analysis

Descriptive statistics were calculated as frequencies with percentages for categorical variables and means with standard deviations for continuous variables. Ordinal categorical variables were coded as discrete numeric variables. Spearman correlation analysis was used to evaluate pairwise correlations, which is used to explore the bivariate relationship of all traits accounted. For this step, all data and variables (breed size standards, appearance traits, and behavioral traits) were included in the analysis, leading to a 33×33 correlation matrix. Factor analysis was performed using a Principal Components method that included an Oblimin rotation to align the factors in the axes. All data were used for this analysis. The factor analysis is used to explore the dimensional construct structure or interconnectivity of the AKC behavioral traits. This approach was conducted using the correlation matrix from the behavioral traits only (traits in "family life", "social", and "personality" categories). The maximum number of factors kept was determined using the default Mineigen option. Hierarchical cluster analysis was performed on individual dog breeds' behavioral data (family life, social, and personality traits). This was performed using Ward's method, and distances are presented using semi-partial R-square values (SpRSq) to present the homogeneity of merged clusters; this measurement indicates how similar the clusters are to each other. This clustering process allows for the direct comparison of behavioral trait profiles for each breed included in the analysis. We present a hierarchical cluster analysis with all AKC-recognized breeds with FSS breeds excluded and one more with the FSS breed included. All statistical analyses were performed using SAS/STAT v.9.4 (SAS Institute Inc., Cary, NC, USA). Statistical significance was declared at $p \leq 0.05$.

3. Results

The study included data for 286 individual dog breeds. AKC main groups were represented as follows: 33 breeds in the Herding group, 34 in the Hound group, 21 in the Non-Sporting group, 33 in the Sporting group, 31 in the Terrier group, 23 in the Toy group, and 32 in the Working group. There were also 12 breeds in the Miscellaneous group and 67 in the FSS.

3.1. Pairwise Correlations among All Traits

Breed size descriptions, appearance, and personality traits were evaluated using Spearman's correlation to identify direct pairwise correlations and are presented in Figure 1. This correlation analysis revealed several patterns. First, height, weight, and life expectancy are strongly correlated, where height is strongly positively correlated with weight, but both are inversely correlated with life expectancy. More simply, taller breeds tend to be heavier but with a reduced life expectancy. Appearance traits showed some correlation, where the most notable are that the shedding level and grooming frequency are associated with many specific coat characteristics, such as short coat types, requiring significantly less grooming as opposed to long coats. Drooling was only correlated to shedding level and hairless breeds, where dogs that drool more also shed more. Behavioral traits are most often positively associated with each other except for watchdog/protectiveness, which is negatively correlated to the traits of being good with other dogs, being good with children, and openness.
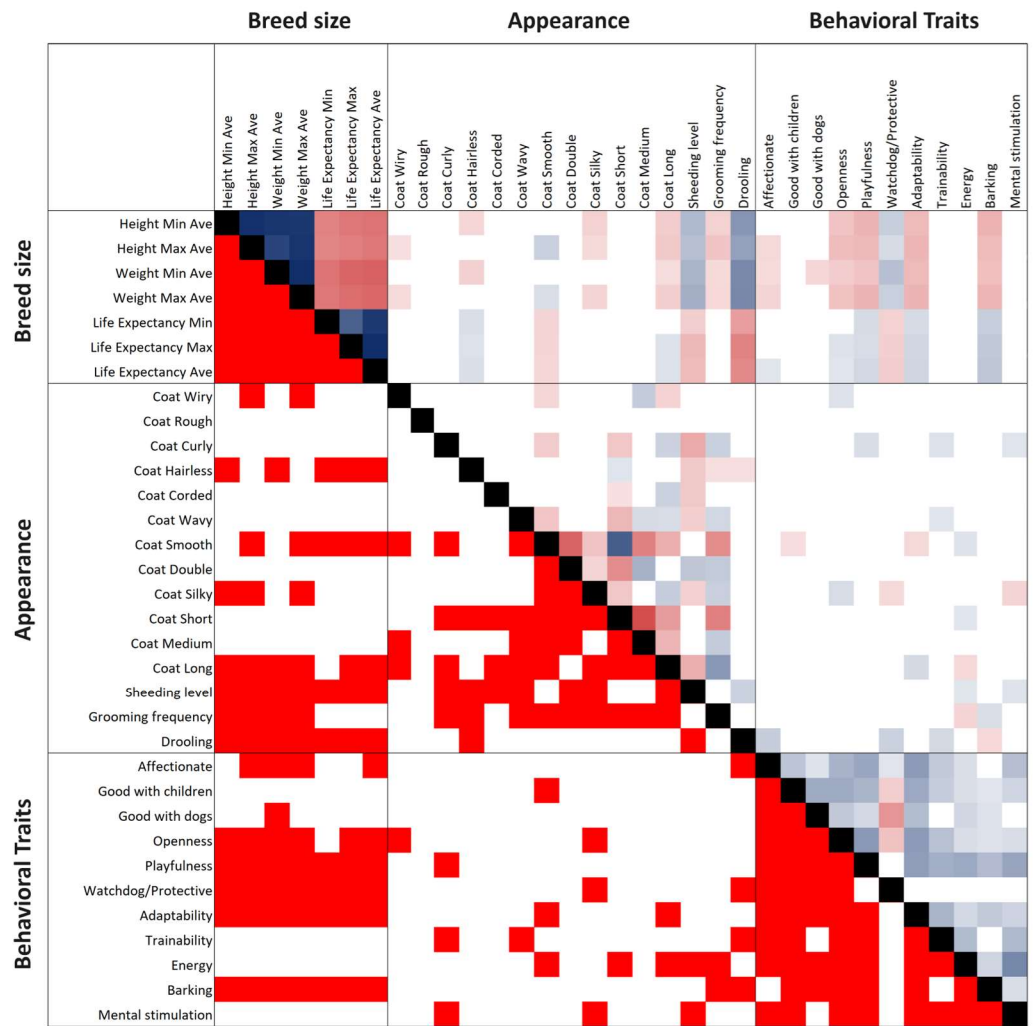
Figure 1. AKC breed size, appearance, and behavioral trait correlation analysis. Bottom left diagonal indicates *p*-values being larger (white) or smaller (red) than the 0.05 significance threshold, while the top right diagonal indicates the correlation coefficient (effect size) of the pairwise correlation; these effect sizes are colored in a gradient from the negative (r = −1, red), passing through neutral (r = 0, white) to the positive (r = 1, blue). Only significant effect sizes are presented. In this table, all 286 breeds are included.

Correlations between appearance and breed size traits were common for shedding level and drooling, whereas large breeds shed and drool more. Smaller breeds more often have long coats and require more grooming. Curiously, hairless breeds and long coat breeds have longer life expectancies and dogs with smooth coats have lower life expectancies. Behavioral trait and breed size correlations display moderate effect sizes; these correlations reveal interesting patterns where small breeds are more affectionate, open, playful and are more adaptable but bark more than larger dogs. The watchdog/protectiveness trait is more often observed in large dog breeds. Lastly, the correlation between behavioral traits and appearance revealed small effect sizes that do not have easily recognizable patterns.

3.2. Interconnectivity (Factor Analysis) among Behavioral Traits

To explore the internal structure of behavioral trait ratings (traits within the family life, social, and personality categories) among AKC breed descriptions, we used exploratory factor analysis. Three factors were retained in this analysis through the Mineigen option, explaining 56.07% of the total variance. Unrotated and rotated factor patterns are presented in Figure 2. From these three retained factors, we identified the following constructs: the

construct defined by Factor 1, dubbed "Social Engagement", explains 30.99% of the total variance and presents a dimension with traits directly relevant to human–dog interactions. Traits that are well aligned on this axis (on the rotated factor pattern, Figure 2D,E) are "Openness", "Affectionate", "Adaptability", "Trainability", and "Good with Children". The construct defined by Factor 2, dubbed "Pet Demands", explains 14.45% of the total variance and presents a dimension with traits that define the drive of the dog, which indirectly suggests how much attention the pet will need from the owner. The main traits in this axis are "Energy", "Mental Stimulation", "Playfulness", and "Barking" (on the rotated factor patterns, Figure 2D,F). "Playfulness" displays an overlap between Factors 1 and 2. The construct defined by Factor 3, dubbed "Vigilance", explains 10.63% of the total variance and presents a dimension directly reflecting the pet's vigilance capacity towards strangers, other dogs, or unusual situations. The "Watchdog/Protective" trait aligns well to the positive side of this dimension's axis, whereas the traits "Good with Dogs" and "Good with Kids" align to the negative end of the axis (on the rotated factor pattern, Figure 2E,F). This strongly suggests that more vigilant breeds are less tolerant of other dogs and children. Curiously, "Barking" does not align well with this axis, suggesting that barking is a trait that is not necessarily reflective of vigilant behavior.
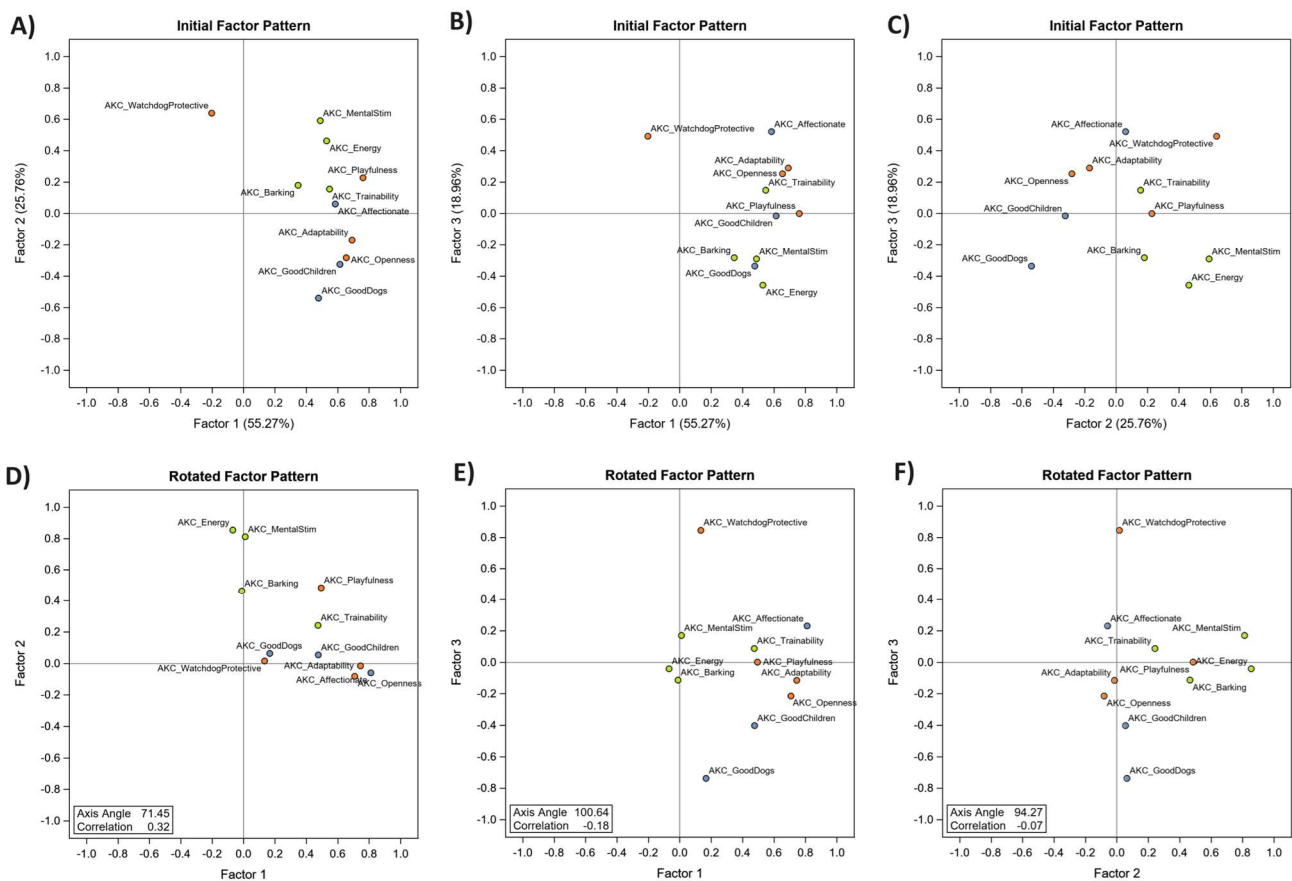

Figure 2. Exploratory factor analysis factor patterns for AKC behavioral traits. Panels (**A**–**C**) present unrotated initial factor patterns for the first 3 factors. In these three panels, percentages represent the proportion of the final communality estimates for each factor. Panels (**D**–**F**) present Oblimin rotated factor patterns.

A path diagram is presented in Figure 3, where these three factors show that the three constructs defined in this study (social engagement, pet demands, and vigilance) do not align with the three behavioral trait group labels defined by AKC (family life, social, and personality), as our factors show several associations across AKC groups. Two traits have an overlap with two factors: "Good with Children" shows an overlap across Factors 1 and

3, while "Playfulness" shows overlap across Factors 1 and 2. The path diagram solution using a process flow algorithm further confirms the interpretation made on the unrotated and rotated factor patterns.
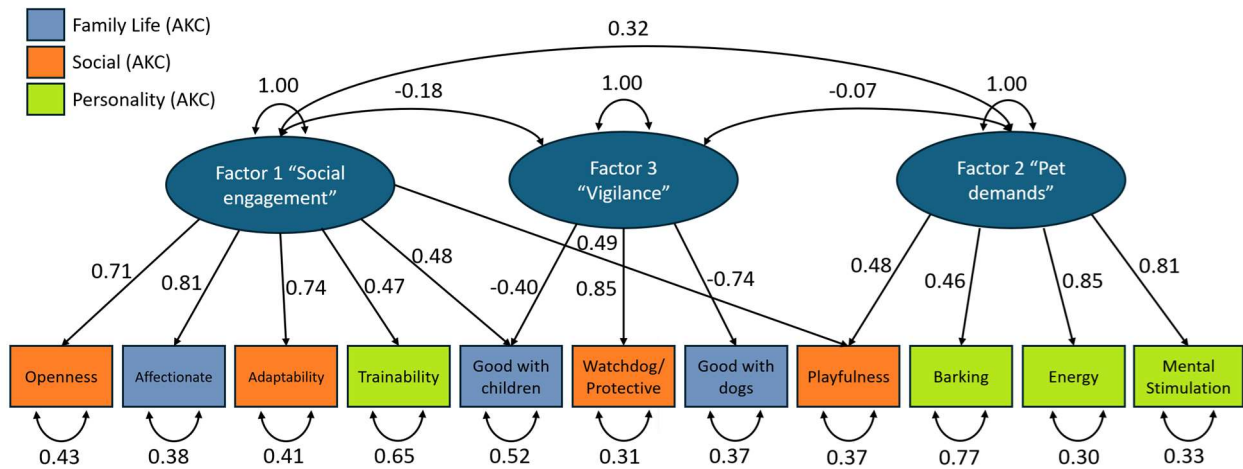

Figure 3. Path diagram of AKC breed profile behavioral traits. AKC behavioral trait groups (family life, social, and personality) are labeled with distinct colors. Factor correlations are presented for each link between factors and variables.

3.3. Behavioral Similarity among All Breeds

Hierarchical cluster analysis was run on all behavioral data from all breeds except for FSS breeds. This cluster analysis is presented in Figure 4. A version of this analysis that included FSS breeds is also available as Supplementary Materials. Cluster analysis revealed two main clades, separating at SpRSq = 0.1625. Subsequent clusters were separated downstream from these two main clades, with one of these one separating again at 0.0776; these three intermediate clades compile roughly a third of the breeds each. We did not interpret the peculiarities of the clades but commented on the patterns formed based on their AKS breed groupings. In the dendrogram, each breed included in the cluster analysis was labeled by its respective AKC breed group; this labeling revealed interesting patterns where some clades showed substantial breed group consistency while others displayed a large amount of heterogeneity of breed groups. There was more consistency among breeds in the Herding, Hound, and Sporting breed groups (dark red, red, and orange Figure 4, respectively), with members of these groups clustering in closer clades. Breeds in the Terrier and Working groups showed some intermediate consistency, with the Working group clustering closely with Herding and Hound breeds. The lowest consistency could be observed for breeds in the Non-Sporting, Toy, and Miscellaneous groups, with members of these group being spread out among all intermediate subclades and not forming intra-group clusters.
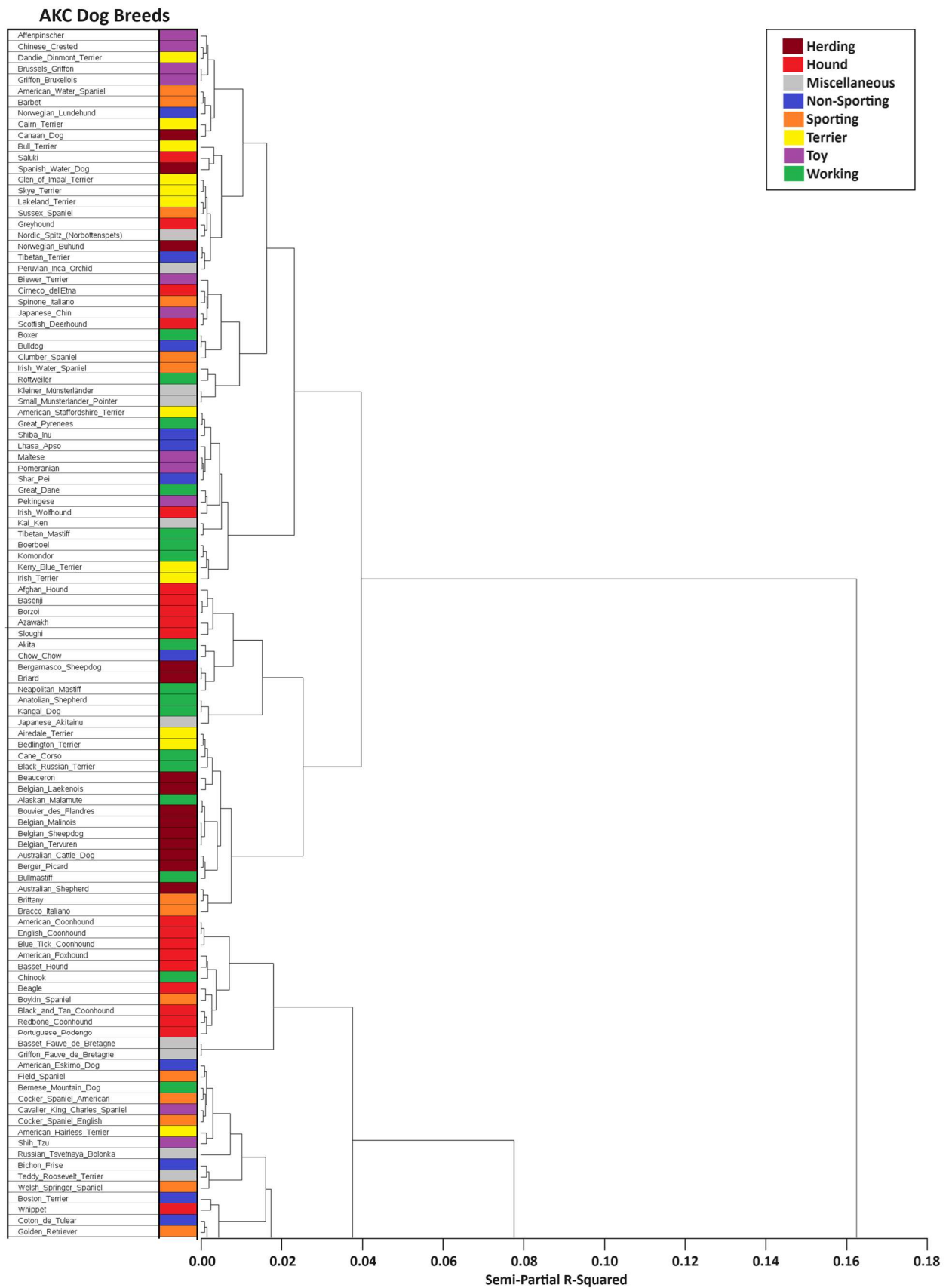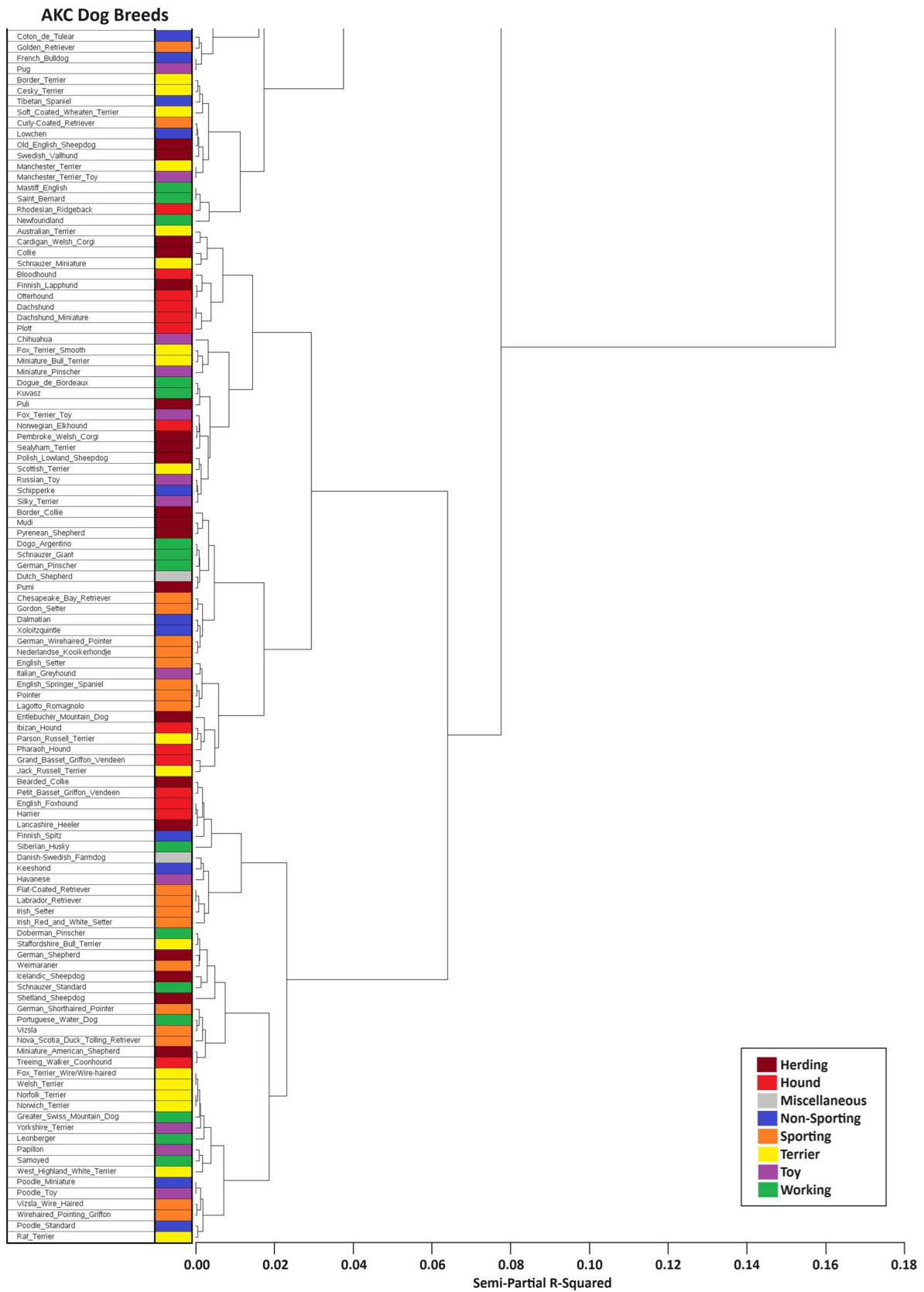
Figure 4. *Cont.*

Figure 4. Hierarchical clustering of AKC behavioral breed descriptions. This figure was split into two; this panel presents the top of the figure. Breed groups are labeled for each breed.

Some aspects of the clustering are of particular interest. For example, there are breeds in the Hound group, such as the Afghan Hound, Basenji, Borzoi, Azawakh, and Sloughi groups clustered together in the same clade. These breeds share morphological, geographical, and cultural heritages that make this grouping logical. However, Belgian Herding breeds, such as Bouvier des Flanders, Belgian Malinois, Belgian Sheepdog, and the Belgian Tervuren, which are closely related, cluster together with the Alaskan Malamute, which is completely outside of the geographic area. In another set of examples, two giant breeds, the Great Dane and the Irish Wolfhound, are clustered together with a Toy breed: the Pekingese. Lastly, the Coton de Tulear, Golden Retriever, French Bulldog, and Pug all form a very highly heterogenous clade; these four breeds are all in separate groups, share no historical or cultural context, and are a mix of mesocephalic and brachycephalic breeds with large variations in size. These examples highlight how, for certain clades, there is a strong background basis, while for others, this appears to be non-existent.

In summary, the correlation analysis indicates that dog size traits are the most highly correlated to behavioral traits, followed by some appearance maintenance traits. The factor analysis suggests that there are three main constructs captured by these AKC behavioral traits, which we named "Social Engagement", "Pet Demands", and "Vigilance". The constructs that we identified do not wholly reflect the trait group labels assigned by the AKC.

Finally, the hierarchical clustering analysis performed and labeled by breed group indicated that breed group expectations are not straightforward to interpret, with some breeds being clustered together with defined morphological, historical, and cultural backgrounds but with also other breeds with no apparent background clustering together.

4. Discussion

Our investigation explored the relationships in AKC breed standards with a special focus on behavioral descriptors from several angles: the broad association with dog size traits (height and weight) and broad appearance (coat characteristics and maintenance requirements); the dimensional analysis of AKC behavioral breed standards and the clustering pattern of dog breeds and breed groups based on their behavioral descriptions.

Our investigation of the pairwise correlations among all traits revealed two main trends: firstly, that there is a clear link between size (height and weight) and life expectancy. This phenomenon has been studied academically for decades [16–18], so its relevance as a new finding is negligible, apart from adding some credibility to the AKC's descriptions of these traits. Secondly, this analysis revealed some minor relationships between the size and appearance of a dog and its behavior, although due to the nature of the data and magnitude of the effect, we judge the overall effect of appearance on behavior in dogs to be quite limited and too abstract to be practical.

Factor analysis on AKC behavioral traits revealed much more surprising results. Based on the interconnectivity of the traits we considered, we may conclude that although the AKC's behavioral trait rankings are indeed measuring three attributes of dog behavior, they are not describing the three characteristics that the AKC has grouped them under. As seen in the factor correlation path diagram (Figure 3), the AKC's trait category label, which aligns best with our calculated constructs, is "Personality", but the other two labels are mostly arbitrary and are not representative of the trends that the various traits are measuring. Furthermore, two traits align with multiple factors, indicating an important degree of overlap of multiple factors. We suspect that this inconsistency may be due to the aim of these rankings rather than a lack of knowledge on dog behavior; a breed's standards are authored by the breed's specific kennel club within the AKC rather than a centralized AKC effort on the full set of breeds they represent. Further research is required for validation of the identified constructs and their applicability to pet ownership.

Furthermore, although the AKC behavior groups do not necessarily align with the underlying behavioral tendencies of dogs [19], they are relevant from the perspective of a dog owner. These constructs describe traits that are relevant to the environment, and

that would be relevant on a daily basis, such as the dog's personality, their behavior at home and public spaces, along with their overall approach to human interactions. As such, we speculate that the AKC breed descriptions might intentionally prioritize the owner's perspective of owning a dog over accurately depicting the components of dog behavior. The complete breed standards provided by the member kennel clubs tend to have quite ambiguous and brief standards for behavior. For example, the Afghan hound's official temperament is described as "aloof and dignified, yet gay" and states that the dog should "gaze into the distance as if in memory of ages past" [20]. The Otterhound's temperament description is simply, "The Otterhound is amiable, boisterous and even-tempered" [21]. Using a romanticized profile is a benefit to breeders and owners as it increases their breed relevance. This perception is important in the determination of breed status and value [3,4,6]. We believe that the AKC's public breed descriptions should aim to focus their descriptions on breed's specific needs as house pets for the pet-seekers who want a specific look but are unfamiliar with the breed.

Our choice to explore behavioral breed tendencies was inspired by a similar hierarchical cluster analysis conducted by Wilson et al. in 2018 using the C-BARQ behavioral database [22]. In contrast to that study by Wilson and collaborators, our study does not focus its narrative on the clustering of defined dog groups; our study focuses on exploring the nature and representativeness of AKC behavioral descriptors. Our dendrogram did not show a consistent pattern in the clade groupings, as some clades seemed to aggregate in agreement with aspects of the breeds' shared history, while other clades did not seem to have any other unifying trait other than those formed by their AKC behavior similarities. We believe that this is either due to the traits correctly illustrating that lineages are an inconsistent method to predict a breed's behavior or, more likely, that the AKC behavioral rankings alone paint an incomplete picture. However, it is uncertain whether the behavioral ratings themselves are incorrect or if there is an over/underrepresentation of factors that determine breed behavior. There is no way to corroborate these descriptors because no individualized behavioral assessment of dogs within a breed is disclosed by individual breed associations or the AKC.

Moreover, it is crucial to keep in mind that our method of analysis and conclusions in our study are greatly impacted by the nature of AKC data. Apart from knowing that the constituent kennel clubs set their breed's standard, there is otherwise extraordinarily little information regarding how breed standards are set and how the various Likert scales presented on the AKC website are determined and interpreted across breed clubs. Additionally, C-BARQ data have revealed that temperaments tend to vary within breeds [23,24], but the AKC does not disclose how this variability is approached when individual kennel clubs set their breed standards. As we cannot determine the accuracy or reliability of trait measurements, we cannot assume that they accurately represent breed traits. Pet owners should be made aware of this limitation; our conclusions are limited to the AKC dataset and serve to provide insight into the inner workings of AKC breed descriptions and contextualize them as a whole. This may be a reflection of owners' tendencies to prioritize the appearance of a breed rather than the breed's behavioral tendencies when choosing a pet [3,4].

5. Conclusions

In summary, although the AKC breed descriptions do collectively show the individual relationships expected in dogs' physical and behavioral data, the traits they measure do not line up very well with the categories they have set and instead reflect traits relevant to human interaction. Furthermore, hierarchical cluster analysis suggests that the behavioral descriptions likely paint an incomplete picture of dogs' behavior overall. Due to the unclear origins behind the AKC descriptions, the claims and interpretations of this investigation remain largely speculative; however, we believe that using standardized observations or familiar data such as C-BARQ as the basis for determining relevant traits and important behavioral factors could greatly improve the behavioral accuracy of AKC breed profiles.

While this may make the behavioral descriptions slightly less approachable to readers, a more accurate representation of behavioral trends in dogs could help veterinary care providers, pet owners, and breeders to better manipulate those behaviors, whether that be in training their dog or breeding a line of dogs to have a specific temperament. For prospective pet owners, this investigation serves to add context to the behavioral profiles that the AKC provides. Knowing the strengths and weaknesses of their information sources can allow for more informed choices when choosing the breed of a new pet.

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